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The Deſcription and Uſe
OF THE
CARPENTERS-RULE:

Together with the uſe of the
LINE of NUMBERS
(Inſcribed thereon)
In Arithmatick and Geometry.
And the Application thereof to the
Meaſuring of *Superficies* and *Solids*,
Gaging of Veſſels, *Military Orders*,
Intereſt and Annuities: with Tables
of Reduction, *&c.*

To which is added,
The Uſe of a (portable) *Geometrical Sun-dial*,
with a *Nocturnal* on the backſide, for the
exact and ready finding the hour of the Day
and Night: And other Mathematical concluſions.

Alſo of a *Univerſal-Dial* for the
Uſe of *Seamen* or others.
With the Uſe of a *Sliding* or *Glaſiers-Rule.*
and Mr. *White's* Rule for Solid meaſure.

Collected and Fitted to the Meaneſt Capacity
By *J. Browne.*

London, Printed by *W. G.* for *William Fiſher*
at the *Poſtern-gate* neer *Tower-hill*. 1667.

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To the Reader.

Courteous Reader, whomſoever thou art;

I *Shall intreat thee to take in good part this Collection of* The Uſes of the Line of Numbers, *commonly called (or beſt known to Artificers by the name of)* Gunter's *Line; I write it not as a new thing, but rather as a renovation of an old one; and the great motive that provoked and ſtirred me up to it is this: I making and ſelling Rules with* Gunter's *Line on them, many a one would ſay to me How ſhall I come to know the uſe of this Line? I reply, that in Mr.* Gunter's *Book there the Uſe is ſet forth, but becauſe of the obſcurity of the Inſtructions there, as to the reading of the Line; and alſo the dearneſs of the Book, many a one that would gladly learn, are deterred from taking pains therein, leſt they ſhould ſpend time and oyl to no purpoſe; and alſo for want of caſes fit to*

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their purpoſe, they are apt to think it is to no purpoſe: Therefore that I might be as an ABCdarian *to the Inſtrumental way of working, being the moſt proper for Mechanick Men, ſuch as* Carpenters, Joyners, Maſons, Bricklayers, *and the like; which for the moſt part are ignorant of Arithmatick; and that knowledge might be increaſed any way, I thought it convenient, and make no doubt of a good benefit to accrue thereby, to them whoſe capacities and purſes in theſe Critical times cannot well reach to other more difficult, and dear Authors: I ſhall not much Apologiſe for my ſelf, as to ſtyle or manner of writing (being like my ſelf;) what it is I beſeech you accept in as good part as it was offered: I might have implored the aid of ſome more abler Pen, but I thought Mechanick men beſt underſtand them of their own profeſſion, in this and other Diſcourſes, becauſe they are men of the ſame ſtature in knowledge and expreſſions.*

ſions. Poſſibly it may provoke ſome to a more accurate and univerſal Treatiſe: In the mean time take this as a Harbinger, till that come. And being apt to think that Ship-carpenters or Sea-faring men may light of it, I have added in the concluſion (as an Appendix) the Uſe of a perticular and Univerſal Sun-dial; alſo of a Nocturnal, or Star-dial; by which the hour of the Day and Night may be had in all places of the North *latitude, from* 1 *degree to* 66.30. *where the day Artificial is* 24 *hours long: In all which I have laboured after brevity and plainneſs, as much as may be: And to the end you may learn to know the Stars, I have been at the charge to print a Paper with all the principal Stars in the* Northern *Hemiſphere*, *from the* Pole *to the* Equinoctial, *ſo that you may take any in that compaſs, and they that pleaſe may do the like for the* South *Hemiſphere. So I wiſh you may reap much profit thereby,* *and remain willing to ſerve you in what I may.*

At the Sphere and
Dial in the great
Minories. *Lond.*
65.

J. B.

The

The Deſcription and Uſe of the Carpenters-Plain-Rule *as it is now made.*

CHAP. I.

I Thought good to add this Chapter for the ſake of ſome, poſſibly young beginners, and them that would not be ignorant altogether in the way of Meaſuring therewith, though they may ſeldom have occaſion of it; and alſo knowing that they that have the moſt knowledge once had little enough: And farther, I find by expe-

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rience, that many there be that can meaſure by the Plain Rule that cannot uſe the Line of Numbers; and ſome alſo know not the uſe of the plain Rule neither: For theſe Reaſons I have added this Chapter of *The Deſcription and uſe of the Carpenters-Plain-rule.*

It is call'd a *Carpenters Rule*,(rather then a *Joyners*, *Bricklayers*, *Maſons*, *Glaſiers*, or the like) I ſuppoſe, becauſe they find the moſt abſolute neceſſity of it in their way, for they have as much or more occaſion to uſe it than moſt other Trades, though the ſame Rule muſt meaſure all kind of Superficies and Solids, which two Meaſures meaſure every viſible ſubſtance which is to be meaſured. And it is uſually made of Box or Holly, 24 Inches in length, and commonly an Inch and half,or an Inch and quarter in breadth; and of thickneſs at pleaſure; and on the one ſide it is divided into 24 equal Inches, according to the Standard at *Guild-hall London*;

London; and every one of thoſe 24 Inches is divided into eight parts, that is, Halfs, Quarters, and Half-quarters; and the Half-inches are known from the Quarters, and Quarters from the Half-quarters, by ſhort, longer, and longeſt ſtrokes; and at every whole Inch is ſet figures, proceeding from 1 to 24, from the right hand toward the left, and theſe parts and figures are on both edges of one ſide of the Rule both ways numbred, to the intent that howſoever you hold the Rule you have the right end to meaſure from, provided you have the right ſide.

On the other ſide you have the Lines of Timber and Board-meaſure. The Timber-meaſure is that which begins at 8 and a half, that is, when the figures of the Timber-line ſtand upright to you, then I ſay it begins at the left end at 8 and $\frac{1}{2}$, and proceeds to 36 within an Inch and $\frac{3}{8}$ of an Inch of the end. Alſo of the beginning end of the Line of Timber-meaſure is a Table of figures, which contains the quantity of the Under-meaſure from one Inch ſquare to eight Inches ſquare, for the figure *9* comes upon the Rule, as you may ſee neer to 8 in the Table.

On or next the other edge, and ſame ſide you have the Line of Board-meaſure, and when thoſe figures ſtand upright, you have *6* at the left or beginning end, and 3*6* at the other (or right) end, juſt 4 Inches of the end unleſs it be divided up to 100, then it is nigh an inch and half of the end. This Line hath alſo his Table of Under-meaſure at the beginning end, and begins at 1 and goes to *6*, and then the diviſions on the Rule do ſupply all the reſt to 100. Thus much for Deſcription: Now for Uſe.

The Inches are to meaſure the length or breadth of any Superficies or Sollid given, and the manner of doing it were ſuperfluous to ſpeak of, or once to mention, being not only eaſie, but even natural to every man, for holding the Rule in the left hand, and applying it to the board or any thing to be meaſured, you have your deſire: But now for the uſe of the other ſide, I ſhall ſhew it in two or three examples in each meaſure that is Superficial or Sollid. And firſt in Superficial or Board-meaſure.

Example the firſt.

The breadth of any Superficies (as Board, or Glaſs, or the like) being given, to find how much in length makes a Square Foot, (or is equal to 12 inches broad, and 12 Inches long; for ſo much is a true Foot Superficial.)

To do this, look for the number of Inches your Superficies is broad in the Line of Board-meaſure, and keep your finger there, and right againſt it on the Inches ſide you have the number of inches that goes to make up a Foot of Board or Glaſs, or any Superficies. Suppoſe I have a peice 8 Inches broad, How many Inches make a Foot? I look for 8 on the Board-meaſure, and juſt againſt my finger (being ſet to 8) on the Inch ſide, I find 18, and ſo many Inches long at that breadth goes to make a Foot Superficial.

Again, ſuppoſe it had been 18 Inches broad, then I find 8 Inches in length, to make a Foot ſuperficial; but if 36 Inches broad, then 4 Inches in length makes a Foot.

Or you may do it more eaſier thus: Take your Rule and hold it in your left hand, and apply it to the breadth of your Board or Glaſs, making the end that is next 36 even with one edge of the Board or Glaſs, and the other edge of the Board ſheweth how many Inches or Quarters of an Inch goes to make a Foot of the Board or Glaſs. This is but the converſe of the former and needs no example, for laying the Rule to it, and looking on the Board-meaſure you have your deſire.

Or elſe you may do thus in all narrow peices under 6 inches broad.

As ſuppoſe $3\frac{1}{4}$, double $3\frac{1}{4}$ it makes $6\frac{1}{2}$, then I ſay, that twice the length from $6\frac{1}{2}$ to the end of the Rule ſhall make a foot Superficial, or ſo much in length makes a foot.

Example the ſecond.

A Superficies of any length and breadth to find the Content, that is, how many Foot there is in it.

Having found the breadth, and how much makes one Foot, turn that over as many times as you can, for ſo many Foot is there in that Superficies: But if it be a great breadth, then you may turn it over two or three times, and then take that together, and ſo ſay 2, 4, 6, 8, 10, *&c.* or 3, 6, 9, 12, 15, 18, 21, and till you come to the end of the Superficies. Note that the three ſhort ſtrokes between figure and figure, are the Quarters; as thus, 8 and a quarter, 8 and a half, 8 and three quarters, then 9, *&c.* till you come to 30, and then 30 and a half, 31, *&c.* to 36. And if it be divided any further,

ther, it is to whole Inches only to 100.

The uſe of the Table at the beginning end of the Board-meaſure.

Firſt you have five ranks of figures, the firſt or uppermoſt is the number of inches that any Superficies is broad, and the other 4 are Feet, and Inches, and parts of an Inch that goes to make up a Foot of Superficial meaſure: As for example, at 5 Inches, broad you muſt have 2 Foot, 4 Inches, and 4 Fifths of an Inch more, that is, 4 parts of 5, the Inch being divided into 5 parts; but where you have but two figures beſide the uppermoſt, and Ciphers in the reſt, you muſt read it thus, At two Inches broad you muſt have ſix Foot in length, no Inches no parts.

Thus much for the Uſe of the Line of Superficial or Board-meaſure.

The Uſe of the Line of (Solid) or Timber-meaſure.

The uſe of this Line is much like

the former: For firſt you muſt learn how much your piece is ſquare, and then look for the ſame number on the Line of Timber-meaſure, and the ſpace from thence to the end of the Rule is the true length at that ſquareneſs, to make a Foot of Timber.

Example.

I have a peice that is 9 Inches ſquare, I look for 9 on the Line of Timber-meaſure, and then I ſay the ſpace from 9 to the end of the Rule is the true length to make a Foot of Timber, and it is neer 21 Inches, 3 eights of an Inch.

Again, ſuppoſe it were 24 Inches ſquare, then I find 3 Inches in length makes a Foot, for ſo I find 3 Inches on the other ſide, juſt againſt 24: But if it were ſmall Timber, as under 9 Inches ſquare, then you muſt ſeek the ſquare in the upper rank in the Table, and right under you have the Feet Inches, and parts that go to make a Foot ſquare, as was in the Table of Board-meaſure. As ſuppoſe 7 Inches ſquare, then you muſt ſeek the ſquare in the upper rank in the Table, and right under you have the Feet Inches, and parts that go to make a Foot ſquare, as was in the Table of Board-meaſure. As ſuppoſe 7 Inches ſquare, I find in the Table 2 Foot 11 Inches, and 2 ſevenths of an Inch, divided into 7 parts, and 8 you find only 2 Foot, 3 Inches--- 0 parts, and ſo for the reſt.

But if a peice be not juſt ſquare but broader at one ſide than the other, then the uſual way is to adde them both together, and to take half for the ſquare; but if they differ much then this way will be very erroneous, and therefore I refer you to the following Rules: But if it be round Timber, then take a ſtring and girt it about, and the fourth part of this is uſually allowed for the ſide of the ſquare, and then you deal with it as if it were juſt ſquare.

Thus much for the Uſe of the Carpenters plain rule.

I have alſo added a Table for the Under-meaſure for Timber & Board to Inches and Quarters; and the uſe is thus: Look on the left ſide for the number of Inches and Quarters, your Timber is ſquare, or your Board is broad, and right againſt it you have the Feet, Inches, tenth part of an Inch, and tenth of a tenth (or hundredth part of an Inch) that goeth to make a Foot of Timber or Board.

Example.

A piece of Timber 3 Inches 1 quar-
F. Inch. 10. 100.
ter ſquare will have 13 7 5 9
parts to make a Foot. And a Board
3 Inches and a quarter broad muſt
F. Inch. 10. 100.
have 3 8 3 0 in length to make
a Foot, and ſo of the reſt, as is plain
by the Table, and needs no further
explication, being common to moſt
Artificers.

A Table for the under Timber-measure to inches & quarters.

Inch.	qu.	feet.	inch.	10p.	100p.
	1	2304	0	0	0
	2	576	0	0	0
	3	256	0	0	0
1	1	144	0	0	0
	1	92	1	9	7
	2	94	0	0	0
	3	47	0	2	4
2		26	0	0	0
	1	28	4	3	3
	2	23	0	4	1
	3	19	0	3	1
3	3	16	0	0	0
	1	13	7	5	9
	2	11	9	0	6
	3	10	1	8	8
4	4	9	0	0	0
	1	7	11	6	6
	2	7	1	3	3
	3	6	4	5	9
5	5	5	9	1	2
	1	5	2	6	9
	2	4	9	1	2
	3	4	4	2	6
6	6	4	0	0	0
	1	3	4	2	3
	2	3	4	9	0
	3	3	1	9	3
7	7	2	11	2	8
	1	2	8	8	6
	2	2	6	7	2
	3	2	4	7	7
8	8	2	3	0	0
8 ½		2	1	3	9

A Table for the Under-Board-m. to Inch. & Qu.

	feet.	inc.	10.	100.
	48	0	0	0
	24	0	0	0
	16	0	0	0
1	12	0	0	0
	9	7	2	0
	8	0	0	0
	6	10	2	9
2	6	0	0	0
	5	4	0	0
	4	9	6	0
	4	4	3	6
3	4	0	0	0
	3	8	3	0
	3	5	1	4
	3	2	4	0
4	3	0	0	0
	2	9	8	8
	2	8	0	0
	2	6	3	1
5	2	4	8	0
	2	3	4	2
	2	2	1	8
	2	1	0	4
6	2	0	0	0
	1	11	0	5
	1	10	1	5
	1	9	3	3
7	1	8	5	8
	1	7	8	6
	1	7	2	0
	1	6	5	8
8	1	6	0	0
8 ½	1	5	4	5

Note alſo, that this Table or any ſmaller part of under-meaſure may be ſupplyed by the diviſions of the board and timber meaſure only as thus; Double the inches and parts of breadth for board-meaſure, or of ſquares for timber-meaſure: and ſeek it in the Lines of board or timber-meaſure, and count twice from thence to the rules end for board or 4 times for timber, and that ſhall be the true length that makes a foot of board or timber.

Example.

At 4 inches and ½ ſquare or broad 4½ doubled is 9. then look for 9 on the board meaſure, and two times from thence to the end ſhall make a foot of board.

Or look for 9 on the Line of timber-meaſure, and 4 times from thence to the end of the Rule ſhall be the true length to make a foot of timber at 4 inches ½ ſquare.

But if it be ſo ſmall a peice that when it is doubled the number is not on the divided part of the rule ; then double it again , and count 4 times for board meaſure , and 16 times for timber.

Example.

At 2 Inches and half a quarter broad, or ſquare , that doubled is $4\frac{1}{4}$, which is not on the rule , therefore I double it again, ſaying, $4\frac{1}{4}$ and $4\frac{1}{4}$ is $8\frac{1}{2}$ which is on the rule; then for board count 4 times from $8\frac{1}{2}$ on the board-meaſure to the upper end by 36 to make a foot of board at $2\frac{1}{8}$ broad : And for timber count 16 times from $8\frac{1}{2}$ neer the beginning of timber meaſure which will be neer 32 foot to make a foot of timber at $2\frac{1}{8}$ ſquare : But if twice doubling will not do , then double again, and count 8 times for board, and 64 times for timber, as in the Table you may ſee which will be very ſlender timber.

The Deſcription and Uſe of the Line of Numbers, (commonly called Gunter's *Line.) In Arithmetick, and Geometry, and Gaging of Veſſels, &c.*

The definition and deſcription of the Line of Numbers, and Numeration thereon.

THE Line of Numbers is only the Logarithmes contrived on a Ruler, and the ſeveral ranks of figures in the Logarithmes are here expreſs'd by ſhort, and longer, and longeſt diviſions; and they are ſo contrived in proportion one to another, that as the

Logarithmes by adding together, and ſubſtracting one from another produce the *queſita*, ſo here, by turning a pair of Compaſſes forward or backward, according to due order, from one point to another, doth alſo bring out the *queſita* in like manner.

For the length of this Line of Numbers, know, that the longer it is the better it is, and for that purpoſe it hath been contrived ſeveral ways, as firſt into a Rule of two Foot long, and three Foot long by Mr. *Gunter*, and I ſuppoſe it was therefore called *Gunter's Line*. Then that Line doubled or laid ſo together, that you might work either right on, or croſs from one to another, by Mr. *Windgate* afterwards projected in a Circle, by Mr. *Oughtred*, and alſo to ſlide one by another, by the ſame Author; and laſt of all projected (and that beſt of all hitherto, for largeneſs, and conſequently for exactneſs) into a Serpentine, or winding circular Line, of 5, or 10, or 20 turns, or more or leſs, by Mr. *Browne*, the uſes being in all of them in a manner the ſame, only ſome with Compaſſes, as Mr. *Gunter's* and Mr. *Windgate*'s; and ſome with flat Compaſſes, or an opening Index, as Mr. *Oughtred's* and Mr. *Browne's*, and one without either as the ſliding Rules; but the Rules or Precepts that ſerve for the uſe of one, will indifferently ſerve for any: But the projection that I ſhall chiefly confine my ſelf to, is that of Mr *Gunter*'s; being the moſt proper for to be inſcribed on a Carpenters Rule, for whoſe ſakes I undertake this collection of the moſt uſeful, convenient, and proper applications to their uſes in Arithmatick and Geometry. Thus much for definition of what manner of Lines of Numbers there be, and of what I intend chiefly to handle in this place.

The order of the diviſions on this Line of numbers, and commonly on moſt other, is thus, it begins with 1, and ſo proceeds with 2, 3, 4, 5, 6, 7, 8, 9; and then 1, 2, 3, 4, 5, 6, 7, 8, 9, 9, 10; whoſe proper power or order of numeration is thus: The firſt 1 doth ſignifie one tenth of any whole number or integer; as one tenth of a Foot, Yard, Ell, Perch, or the like; or the tenth of a penny, ſhilling, pound, or the like, either in weight, or number, or meaſure; and ſo conſequently, 2 is 2 tenths; 3, three tenths; and all the ſmall intermediate diviſions, are 100 parts of an integer, or a tenth, of one of the former tenths; ſo that 1 in the middle, is one whole integer, and 2 onwards two integers, 10 at the end is 10 integers: Thus the line is in its moſt proper acception or natural diviſion.

But if you are to deal with a greater number then 10, then 1 at the beginning muſt ſignifie 1 integer, and in the middle 10 integers, and 10 at the end 100 integers. But if you would have it to a figure more, then the firſt 1 is ten, the ſecond a hundred, the laſt 10 a thouſand. If you proceed further, rhen the firſt 1 is a 100. the middle 1 a 1000. and the 10. at the end is 10000. which is as great a number as you can well diſcover, on this or moſt ordinary lines of numbers: and ſo far with convenient care, you may reſolve a queſtion very exactly. Now any number being given under 10000. to find the point repreſenting it on the rule, do thus.

Numeration on the line of numbers.

Probl. 1.

Any whole number being given under four figures, to find the point on the Line of numbers that doth repreſent the ſame.

Firſt, Look for the firſt figure of your number, among the long diviſions, with figures at them, and that leads you to the firſt figure of your number: then for the ſecond figure, count ſo many tenths from that long diviſion onwards, as that ſecond figure amounteth to; then for the third figure, count from the laſt tenth, ſo many centeſmes as the third figure contains; and ſo for the fourth figure, count from the laſt centeſme, ſo many millions, as that fourth figure hath unites, or is in value; and that ſhall be the point where the number propounded is on the line of numbers: Take two or three examples.

Firſt, I would find the point upon the line of numbers repreſenting 12. now the firſt figure of this number is one, therefore I take the middle one for the firſt figure; then the next figure being 2. I count two tenths from that 1. and that ſhall be the point repreſenting 12. where uſually there is a braſs pin with a point in it.

Secondly, To find the point repreſenting 144. Firſt, as before, I take for 1. the firſt figure of the number 144 the middle Figure 1, then for the ſecond Figure (*viz.* 4) I count 4. tenths onwards for that: Laſtly, for the other 4. I count 4 centeſmes further, and that is the point for 144.

Thirdly, To find the point repreſenting 1728.

Firſt, As before, for 1000. I take the middle 1. on the line.

Secondly, For 7. I reckon ſeven tenths onward, and that is 700.

Thirdly, For 2. reckon two centeſmes from that 7th. tenth for 20.

And laſtly, For 8. you muſt reaſonably eſtimate that following centeſme, to be divided into 10. parts (if it be not expreſs'd, which in lines of ordinary length cannot be done) and 8. of that ſuppoſed 10. is the preciſe point for 1728. the number propounded to be found, and the like of any number whatſoever.

But if you were to find a fraction, or broken number, then you muſt conſider, that properly, or abſolutely, the line doth expreſs none but decimal fractions: as thus, $\frac{1}{10}$ or $\frac{1}{100}$ or

$\frac{1}{1000}$ and more neerer the rule in common acception cannot expreſs; as one inch, and one tenth, or one hundredth or one thouſandth part of an inch, foot, yard, perch, or the like, in weight, number, or time, it being capable to be applyed to any thing in a decimal way: (but if you would uſe other fractions, as quarters, half quarters, ſixteens, twelves, or the like, you may reaſonably read them, or elſe reduce them into decimals, from thoſe fractions, of which more in the following Chapters;) for more plaineſs ſake, take two or three obſervations:

1. That you may call the 1. at the beginning, either one thouſand, one hundred, or one tenth, or one abſolutely, that is, one integer, or whole number, or ten integers, or a hundred, or a thouſand integers, and the like may you call 1. in the middle, or 10. at the end. 2. That whatſoever value or denomination you put on 1, the ſame value or denomination all the other figures muſt have ſucceſſively, either

increaſing forward, or decreaſing backwards, and their intermediate diviſions accordingly, as for example;

If I call 1 at the beginning of the line, one tenth of any integer, then 2 following muſt be two tenths, 3. three tenths, &c. and 1 in the middle 1 integer, 2 two integers, and 10 at the end muſt be ten integers.

But if one at the beginning be one integer, then 1 in the middle muſt be 10 integers, and 10 at the end 100 integers, and all the intermediate figures 20, 30, 40, 50, 60, 70, 80, 90 integers, and every longeſt diviſion between the figures, 21, 22, 23, 24, 25, 26, &c. integers, and the ſhorteſt diviſions tenths of thoſe integers, and ſo in proportion infinitely: as [1^{10} 1. 10] [1. 10. 100.] [10. 100. 1000.] [100. 1000. 10000.] in all which 4 examples, the firſt order of Figures, *viz.* $\frac{1}{10}$ 1. 10. 100. is repreſented by the firſt 1. on the line of numbers: the ſecond order of Figures, *viz.* 1, 10. 100. 1000. is repreſented by the middle 1 on the line of numbers: the laſt order or Place of Figures, *viz.* 10. 100. 1000. 10000. is repreſented by the 10. at the end of the line of numbers.

3. That I may be plain (yet further) if a number be propounded of 4 Figures, having two cyphers in the middle, as 1005. it is expreſſed on the line between that prime to which it doth belong, and the next centeſme or ſmall diviſion next to it; but if you were to take 5005. where there are not ſo many diviſions, you muſt imagin them ſo to be, and reaſonably eſtimate them accordingly. Thus much for numeration on the line, or naming any point found on the Rule, in its proper value and ſignification.

CHAP. II.

PROBLEME. 1.

Two numbers being given, to find a third Geometrically proportional unto them, and to three a fourth, and to four a fifth, &c.

GEometrical proportion is when divers numbers being compar'd together, differ among themſelves, increaſing or decreaſing, after the rate or reaſon of theſe numbers, 2. 4. 8. 16. 32. for as 2 is half 4. ſo is 8 half 16. and as this is continued, ſo it may be alſo diſcontinued, as 3. 6. 14. 28; for though 3 is half 6. and 14 half 28. yet 6 is not half 14, nor in proportion to it as 3 is to 6: there is alſo Arithmetical, and Muſical proportion; but of that in other more large diſcourſes, being not material to our preſent purpoſe (though I may hint it afterward.)

To find this by the numbers, extend the Compaſſes upon the line of numbers, from one number to another, this done, if you apply that extent (upwards or downwards, as you would either increaſe or diminiſh) from either of the numbers propounded, the moveable point will ſtay on the 3d. proportional number required. Alſo the ſame extent applyed the ſame way from the third, will give you a fourth, and from the fourth a fifth, *&c.*

Example.

Let theſe two numbers 2 and 4 be propounded to find a third proportional to them, (that is, to find a number that ſhall bear the ſame proportion to 4, that 2 doth bear to 4.) and then to that 3d, a fourth, fifth, & ſixth, *&c.*) Extend the Compaſſes upon the firſt part of the line of numbers, from 2 to 4; this done, if you apply the ſame extent upwards from 4, the moveable point will fall upon 8, the third proportional required, and then from 8 it will reach to 16. the fourth proportional, & from 16 to 32 the fifth, and from 32 to 64 the ſixth proportional: but if you will continue the progreſſion further, then remove the Compaſſes to 64 in the former part of the line, and the moveable point will ſtay upon 128 the ſeventh proportional, and from 128 to 256 the eighth, and from 256 to 512 the ninth, *&c.* Contrarily to this, if you would diminiſh, as from 4 to 2, extend the Compaſſes from 4 to 2, and the moveable point will fall on 1, and from 1 to $\frac{5}{10}$ or 5 of ten, which is one half (by the ſecond Problem of the firſt Chapter) and from 5. to 25. or $\frac{2}{2}$ and ſo forward.

But generally in this, and moſt other work make uſe of the ſmall diviſions in the middle of the line, that you may the better eſtimate the fractions of the numbers you make uſe on; for obſerve, look how much you miſs in ſetting the Compaſſes to the firſt and ſecond term, ſo much or more will you erre in the fourth: therefore the middle part will be moſt uſeful; as for example, as 8 to 11, ſo is 12, to 16.50. or 5. if you do imagin one integer to be divided but into 10 parts, as they are on the line on a two foot Rule; but on the other end you cannot ſo well expreſs a ſmall fraction as there you may.

PROB. 2.

One number being given to be multiplyed by another number given, to find the product.

Extend the Compaſſes from 1 to the Multiplicator, and the ſame extent applyed the ſame way from the Multiplicand, will cauſe the moveable point to fall on the product.

Example.

Let *6* be given to be multiplyed by 5, here if you extend the Compaſſes from 1 to 5, the ſame extent will reach from *6* to 30: which number 30 though it be numbred but with 3, yet your reaſon may regulate you, to call it 30. and not 3; for look what proportion the firſt number bears to 1, the ſame muſt the other number (or Multiplycand) bear to the Product, which in this place cannot be 3, but 30.

Another Example for more plainneſs.

Let 125 be given to be Multiplyed by 144,extend the Compaſſes from 1 to 125, and the moveable point will fall on 18000.now read to this number 18000 (ſo much and no more) you muſt conſider, that as in 125 there is two figures more than in 1. ſo there muſt be two figures more in the Product than in the Multiplicand; and as for the order of reading the numbers, you may conſider well the firſt Problem of the firſt Chapter.

Some other Examples for more light.

3. As 1.to 25,ſo 30 to 750 as 1. to 8,ſo 6 to 48. as 1 to 9, ſo 9 to 81. as 1 to 12, ſo 20 to 240. One help more I ſhall add as to the right computation of the laſt figure in 4 figures (for more cannot be well expreſt, (on ordinary lines, as that on

a two foot Rule is) but for the true number of figures in the Product; note, that for the moſt part there is as many as there is in the Multiplycator and Multiplycand put together, when the leſſer of them doth exceed ſo many of the firſt figures of the Product, but if the leaſt of them do not exceed ſo many of the firſt figures of the Product, then it ſhall have one leſs then the Multiplycator and Multiplycand put together, as *92* and *68* Multiplyed makes *6256*, 4 figures; and 12 Multiplyed by 16, makes but 192, 3 figures, for the reaſon above-ſaid: now for right naming the laſt figure, write them down; as thus, 75 by 63. now you Multiply 5 by 3. that is 15. for which you by vulgar Arithmetick, ſet down 5. and carry 1. therefore 5 is the laſt figure in the Product, and it is 4725.

PROBLEM 3. Of Diviſion.

One number being given to be divided by another, to find the Quotient.

Extend the Compaſſes from the Di-

Diviſor to 1, and the ſame extent will reach from the Dividend, to the Quotient, or extend the compaſſes from the Diviſor to the Dividend the ſame extent ſhall reach the ſame way from 1 to the quotient; as for example;

Let 750 be a number given to be divided by 25 (the Diviſor) I extend the Compaſſes downward, from 25 to 1, then applying of that extent the ſame way from 750, the other point of the Compaſſes will fall upon 30, the Quotient ſought; or you may ſay, as 25 is to 750, ſo is 1 to 30.

2. Let 1728 be given to be divided by 12, ſay as 12 is to 1, ſo is 1728 to 144. Extend the Compaſſes from 12 to 1, and the ſame extent ſhall reach the ſame way from 1728 to 144. or as before, as 12 to 1728. ſo 1 to 144.

3. If the number be a decimal fraction, then you work as if it were an abſolute whole number; but if it be a whole number, joyned to a decimal fraction, it is wrought here as

properly as a whole number, example, I would divide 111. 4 by 1.728. extend the Compaſſes from 1. 728. to 1, the ſame extent applyed from 111 4. ſhall reach to 64. 5. ſo again 56. 4. being to be divided by 8. 75. the Quotient will be found to be 6. 45.

Now to know of how many Figures any Quotient ought to coſiſt, it is neceſſary to write the Dividend down, and the Diviſor under it, and ſee how often it may be written under it; for ſo many figures muſt there be in the Quotient, as in Dividing this number 12231, by 27. according to the rules of Diviſion. 27. may be written 3 times under the Dividend: therefore there muſt be 3 Figures in the Quotient; for if you extend the Compaſſes from 27 to 1, it will reach from 12231, to 453. the Quotient ſought for.

Note, That in this, and alſo in all other queſtions, it is beſt to order it ſo, as that the Compaſſes may be at the cloſeſt extent; for you may take a cloſe extent more eaſily and exactly, than you can a large extent, as by experience you will find.

PROB. 4.

To three numbers given to find a fourth in a direct proportion, (or the rule of 3. direct.)

Extend the Compaſſes from the firſt number to the ſecond; that done, the ſame extent applyed the ſame way from the third, will reach to the fourth proportional number required.

Example.

If the Circumference of a Circle, whoſe diameter is 7, be 22; what circumference ſhall a Circle have, whoſe diameter is 14? Extend the Compaſſes upward from 7 in the firſt part, to 14 in the ſecond, and that extent ayplyed the ſame way, ſhall reach from 22 to 44. the fourth proportional required; for ſo much ſhall the circumference of a Circle be, whoſe diameter is 14. - and the contrary if the circumference were given.

Again, A ſecond Example, if 8. foot of Timber be worth 10 ſhillings, how much is 12 foot worth? extend the Compaſſes from 8 to 10, (either in the firſt part or ſecond) the ſame extent applied the ſame way from 12, ſhall reach to 15. which is the anſwer to the queſtion; for ſo many ſhillings is 12 foot worth.

PROBL. 5.

Three numbers being given to find a fourth in an inverſed proportion, (or the back Rule of 3.)

Extend the Compaſſes from the firſt of the numbers given, to the ſecond of the ſame denomination, if that diſtance be applyed from the third number backwards, it ſhall reach to the fourth number ſought.

If 60 pence be 5 ſhillings, how much is 30 pence? *facit* 2. 5. two ſhillings, five tenths of a ſhilling, that is, being reduced, 2 ſhillings 6 pence.

Again, If 60 men can raiſe a Breſt-work of a certain length and breadth in 48 hours, how long will it be ere

40 men can raiſe ſuch another ? Extend the Compaſſes from *60.* to 40. numbers of like denomination, *viz.* of Men; this done, that extent applyed the contrary way from 48. will reach to 72, the fourth number you look for. Therefore I conclude that 40 men will perform as much in 72 hours as 60 men will do in 48 hours.

Note, That this back Rule of 3, may for the moſt part be wrought by the direct Rule of 3.

If you do but duely conſider the order of the Queſtion, for you muſt needs grant that fewer men muſt have longer time, and the contrary therefore the anſwer muſt be in proportion to the queſtion, which might have been wrought thus as well. The Extent from 40 to 60 will reach the ſame way from 48 to 72 in direct proportion: Or contrarily, as 60 to 40, ſo is 72 to 48. which you ſee is but by Turning the queſtion to its direct opperation, according to the true reaſon of the queſtion.

Thus you have the way for the direct and reverſe rule of 3: for the double rule of 3, and Compound rule of 3, this is the rule for it.

Alwayes in the double rule of 3, 5 terms are propounded, and a ſixth is required, 3 of which terms are of ſuppoſition, and two of demand; now the difficulty is in placing them, which is beſt done thus; as in this Example.

If 5 Scholars ſpend 20 *l.* in 3 months, How many pounds will ſerve *9* Scholars for *6* months?

Note here the terms of ſuppoſition are the firſt three, *viz.* 5, 20, and 3, and the terms of demand are *9* and *6*.

Then next for the right placing them obſerve which of the terms of Suppoſition is of the ſame denomination with the term required, as here the 20 *l.* is of the ſame denomination with the how many pounds required. Set that always in the ſecond place, and the two terms of ſuppoſition one above another in the firſt place, and the terms of demand one above another in the laſt place thus,

5---20---9
3--*pounds*-6

Then the work is performed by two ſingle rules of 3 direct, thus:

Extend the Compaſſes from 5 to 20. the ſame extent applyed the ſame way from 9 ſhall reach to 369 a 4th. this is the firſt operation: Then as 3 to 36: the 4th. ſo is 6 to 72 the number of pounds required. By the line of numbers the double rule is wrought as ſoon as the compound: therefore I ſhall wave it now:

Four Queſtions and their Anſwers, to ſhew the various forms of working on the line of numbers.

1. If 12 men raiſe a frame in ten days, in how many days might 8. men raiſe the like frame? Reaſon tells me, that fewer men muſt needs have longer time; therefore the work is thus, as 12 is to 8, ſo is 10, to 15, by the laſt Rule, or 8 to 10, ſo is 12 to 15.

2. If 60 yards of ſtuff, at 3 quarters of a yard broad, would hang about a certain room; how many yards of ſtuff of half a yard broad, will ſerve to hang about the ſame room? the work is thus, as 5 10th to 7 10th ½ ſo is 60, to 90, or as 7 5 to 5, ſo is 60 to 90, wrought backwards.

3. If to make a foot ſuperficial, 12 inches in breadth, do require 12 inches in length, the breadth being 16 inches, how many inches in length muſt I have to make a foot ſuperficial? the work is thus, as 16 is to 12, ſo is 12 to 9, the number of inches to make a foot.

4. If to make a foot ſolid, a baſe of 144 inches require 12 inches in height, a baſe being given of 216 inches, how much in height makes a foot ſolid? the work then is, as 216 is to 144, ſo is 12 to 8. or otherwiſe thus, as 12 is to 216, ſo is 144 to 8. the height ſought.

PROB. 6.

To three numbers given to find a fourth in a doubled proportion.

This Problem concerns queſtions of proportions between lines and ſuperficies : now if the denomination of the firſt and ſecond terms be of lines, then extend the Compaſſes from the firſt term to the ſecond, (of the ſame kind or denomination,) this done, that extent applyed twice, the ſame way from the third term , the moveable point will ſtay upon the fourth term required.

Example.

If the Content of a Circle, whoſe diameter is 14, be 154, what will the content of a Circle be, whoſe diameter is 28 ?

Here 14 and 28 having the ſame denomination, *viz.* of lines, I extend the Compaſſes from 14 to 28 , then applying that extent the ſame way, from 154 twice, the moveable point will fall on *616* the fourth proportional ſought, that is, firſt from 154 to 308, and from 308 to *616.*

But if the firſt denomination be o ſuperficial content, then extend th Compaſſes unto the half of the diſtance, between the firſt and ſecond o the ſame denomination; ſo the ſam extent will reach from the third to the fourth example.

If the content of a Circle, bein 154, have a diameter that is 14, wh ſhall the diameter of a Circle be whoſe content is 616? Divide the diſtance betwixt 154 and 616 into equal parts, then ſet one foot in 14 the other ſhall reach to 28, the diameter required.

The like is for Squares; for If ſquare whoſe ſide is 40 foot, contai 1600 foot: how much ſhall a ſquar contain, whoſe ſide is 60 foot? Tak the diſtance from 40 to 60, and appl it twice from 1600, and the moveable point will ſtay on 3600, the content ſought for.

PROBL. 7

PROBL. 7.

To three numbers given to find a fourth in a triplicated proportion.

The uſe of this Problem, conſiſteth in queſtions of proportion, between lines and ſolids, wherein if the firſt and ſecond terms have denomination of lines, then extend the Compaſſes from the firſt to the ſecond, that extent applyed three times from the third, will cauſe the moveable point to ſtay on the fourth proportional required.

Example.

If an Iron Bullet, whoſe Diameter is 4 inches, ſhall weigh 9 pounds; what ſhall another Iron Bullet weigh, whoſe Diameter is 8 inches? Extend the Compaſſes from 4 to 8, that extent applyed the ſame way 3 times form 9, the moveable point will fall at laſt on 72; the fourth proportional and weight required, that is, in ſhort thus, as 4 to 8 ſo 9 to 18, ſo 18 to 36, ſo 36 to 72.

But if the two given terms be

weight, or contents of ſolids, and (the Diameter or ſide of a ſquare, or) a line is ſought for, then divide the ſpace between the two given terms of the ſame denomination into three parts, and that diſtance ſhall reach from the third to the fourth proportional. *Example.*

Divide the ſpace between 9 and 72 in three parts, that third part ſhall reach from 8 to 4 (or from 4 to 8, as the queſtion was propounded, either augmenting or diminiſhing.)

Alſo if a cube whoſe ſide is 6 inches contain 215 inches, how many inches ſhall a cube contain, whoſe ſide is 12 inches; Extend the Compaſſes from 6 to 12, that extent meaſured from 216 in the firſt part of the line of numbers three times, ſhall at laſt fall upon 1728, in the ſecond part of the line of numbers; for note, if you had begun on the ſecond part, you would at three times turning, have fallen beyond the end of the line, and the contrary as above, holds here in ſquares alſo. *PROB.* 8.

PROB. 8.

Betwixt two numbers given to find a mean arithmetically proportional.

This may be done without the help of the line of numbers: neverthele〈ſ〉s, becauſe it ſerves to find the next following, I ſhall here inſert it, though I thought to paſs both this and the next over in ſilence, yet to ſet forth the excellency of number, I have ſet them down; and the Rule is this, *Add half the difference of the given terms to the leſſer of them, and that aggregate (or ſum) is the Arithmetical mean required.*

Example.

Let 20 and 40 be the terms given, now if you ſubſtract one out of the other, their difference is 60, whoſe half difference 30, added to 20, the leſſer term makes 50, and that is the Arithmetical mean ſought.

PROB. 9.

Betwixt two numbers given to find a mean muſically proportional.

Multiply the difference of the

terms by the leſſer term, and add likewiſe the ſame terms together; this done, if you divide that Product by the ſum of the terms, and to the Quotient add the leſſer term, that laſt ſum is the Muſical mean required: or ſhorter thus,

Multiply the terms one by another, and divide the Product by their ſum, and the Quotient doubled is the Muſical mean required.

Example

The numbers given being 8 and 12 multiplyed together, make *96*, that divided by 20, the ſum of 8 and 12, the Quotient is 4^{80}, which doubled is $9\text{-}6^{10}\ ^{s}$, the Muſical mean required. This may be done by the line of numbers; otherwiſe thus, find the Arithmetical mean between 8 and 12, and then the analogy or agreement is thus,

As the Arithmetical mean found is to the greater term, ſo is the leſſer term to the Muſical mean required.

PROB.

PROB. 10.

Betwixt two numbers given to find a mean Geometrically proportional.

Divide the ſpace on the line of numbers, between the two extreme numbers, into two equal parts; and the point will ſtay at the mean proportional required. So the extreme numbers being 8 and 32, the middle point between them will be found to be 16.

PROB. 11.

Betwixt two numbers given to find two means Geometrically proportional.

Divide the ſpace between the two extreme numbers into 3 equal parts, and the two middle points, dividing the ſpace ſhall ſhew the two mean proportionals. As for example, let 8 and 27, be two extremes, the two means will be found to be 12, and 18, which are the two means ſought for.

PROB. 12.

To find the Square root of any number under 1000000.

The Square root of every number

is always the mean proportional between 1, and that number for which you would find a ſquare root; but yet with this general caution, if the figures of the number be even, that is 2, 4,6,8,10,&c. then you muſt look for the unit (or one) at the beginning of the line, and the number in the ſecond part, and the root in the firſt part, or rather reckon 10 at the end to be the unit, and then both root and ſquare will fall backwards toward the middle in the ſecond length or part of the line: but if they be odd, then the middle one will be moſt convenient to be counted the unity, and both root and ſquare will be found from thence forwards toward 10. ſo that according to this rule, the ſquare of 9, will be found to be 3, the ſquare of 64, will be found to be 8, the ſquare of 144, to be 12. the ſquare of 1444, to be 38. the ſquare of 57600; to be 240. the ſquare of 972196, will be found to be 986. and ſo for any other number.

Now to know of how many figures any root ought to conſiſt, put a prick under the firſt figure, the third, the fifth and the ſeventh, if there be ſo many; and look how many pricks, ſo many Figures there muſt be in the Root.

PROB. 13.

To find the Cubique Root of a Number under.

1000000000.

1 1 1 1

The Cubique root is always by the firſt of two mean proportionals between 1 and the Number given, and therefore to be found by dividing the ſpace between them into three equal Parts: So by this means the root of 1728 will be found to be 12, the root of 17280 is neer 26, the root of 172800 is almoſt 56, although the point on the Rule repreſenting all the ſquare numbers is in one place, yet by altering the unit it produceth various points and numbers, for their reſpective proper roots. The Rule to find which is in this manner: You muſt ſet (or ſuppoſe pricks to be ſet) pricks under the firſt figure to the left hand, the fourth figure, the ſeventh and the tenth; now if by this means the laſt prick to the left hand ſhall fall on the laſt figure, as it doth in 1728, then the unit will be beſt placed at 1 in the middle of the Line, and the Root, the Square and Cube will all fall forward toward the end of the Line.

But if it fall on the laſt but 1, as it doth in 17280 then the unit may be placed at 1 in the beginning of the Line, and the Cube in the ſecond length, or elſe the unit may be placed at 10 in the end of the Line, and the Cube in the firſt part of the Line, you may help your ſelf, as in the firſt Problem of the 2 Chapter.) But if the laſt prick fall under the laſt but two, as in 172800, it doth then place the unit always at 10 in the end of the Line, then the Root, the Square, and Cube, will all fall backward, and be found in the ſecond part, between the middle 1 and the end of the Line. By theſe Rules it doth appear that the Cube root of 8 is 2, of 27 is 3, of 64 is 4 of 125 is 5, of 216 is 6, of 345 is 7, of 512 is 8, of 729 is 9, of 1000 is 10. As you may ſee by this following Table of Square and Cubique roots.

Thus you have the chief uſe of the line of numbers in general, and they that have skill in the rule of three and a little knowledge in plain triangles, may very aptly apply it to their particular purpoſes, Yet for their ſakes for whom it is intended, I ſhall inlarge; to ſome more particular applications in meaſuring all ſorts of Superficies, and Solids; wherein I do judge it will be moſt ſerviceable to them that be unskilful in Arithmetick, as beforeſaid.

A Table of Square and Cubique Roots.

Root.	Square.	Cubc.	Root.	Square.	Cube.	Root.	Square.	Cube.
1	1	1	7	49	343	204	41616	8489664
2	4	8	8	64	512			
3	9	27	9	81	729	439	192721	84604519
4	16	64	10	100	1000			
5	25	125	12	144	1728	947	896809	849278123
6	36	216	26	676	17576			
			56	3136	175616	1000	1000000	1000000000

CHAP. III.

The Uſe of the Line of Numbers in meaſuring any Superficial meaſure, as Board, Glaſs, and the like.

The ordinary meaſure, and moſt in uſe, is a *Twofoot Rule*, divided into 24 Inches, and every Inch into 8 parts; that is, Halfs, Quarters, and Half-quarters; but theſe parts not agreeing with the parts on the Line of Numbers, which are Decimals, or tenth parts, is bred very much trouble; and there cannot be exactneſs without taking of ſmall parts, as ½ quarters of Inches, or elſe uſing of Reduction; and it is alſo as troubleſom by Arithmetick as by the Line of Numbers. To avoid which, I would adviſe either to meaſure altogether by Foot-meaſure, (that is, a Foot divided into 1000 parts (or rather as is ſufficient for ordinary uſe, 100) and then the

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diviſions on the numbers will agree fitly to the parts on your Rule, without any trouble for fractions; for ſo doing, Fractions do become whole Numbers as it were, and are wrought accordingly: But if you uſe it not in meaſuring, yet you may have it ſet for to help you for the ready reducing of ſuch Numbers as ſhall require it, though I ſhall apply it to Inches alſo, as it is commonly uſed, that it may appear uſeful both ways, accordingly as any man ſhall be affected.

The like reaſon holdeth for Inches, Yards, Ells and Perches, or any other meaſure; for thereby the Work is made more eaſie, as ſhall appear anon.

Therefore firſt by Foot-meaſure only.

PROP. 1.

The breadth of an Oblong ſuperficies given in Foot-meaſure, to find how much in length makes a Foot.

Extend the Compaſſes from the breadth to 1, the ſame extent applyed the ſame way from 1, will reach to the length required.

So the breadth being 8 tenths, or 0, 80, the length to make a Foot Superficial will be found to be 1. 25. Or ſhorter thus, as 8 tenths (or 80 of a 100) is to 1, ſo is 1 to 1, 25 of an hundred.

PROB. 2.

Having the length and breadth of any Superficies given in Foot-meaſure, to find the content of that Superficies in Foot-meaſure.

Extend the Compaſſes from 1 to the breadth, the ſame extent applyed the ſame way from the length, will reach to the Content.

Example.

As 1 is to 8, the breadth; ſo is 15 the length to 12, the content required; for a peice of 8 tenths broad and 15 Foot long, containeth 12 Foot.

PROB. 3.

PROB. 3.

Having the breadth and length of an Oblong Superficies given in Inches, to find the content in Inches.

As 1 Inch to the breadth in Inches, ſo the length in Inches to the Content in ſquare Superficial Inches.

So the breadth 30 Inches, and the length 183, the Content will be found to be 5490.

Or elſe, as 1 to 183, ſo is 30 to 5490 Inches.

PROB. 4.

Having the breadth and length of an Oblong ſuperficies given in Inches, to find the Content in feet.

As 144 the number of Inches in one Foot, is to the breadth in Inches; ſo is the length in Inches unto the Content in Feet. So as 144 to 30, ſo is 183 to 38,250, that is, to 38 Foot and a quarter.

PROB. 5.

Having the breadth of an Oblong ſuperficies given in Inches, and the length in Feet and parts, to find the Content in Feet, and ſuch like parts as the length was.

As 12 to the breadth in Inches, ſo is the length in Feet to the Content in Feet.

As 12 unto 30, ſo is 15 to 37,50.

PROB. 6.

Having the breadth in Inches, to find how much makes a Foot in Inch-meaſure, (that is, how many Inches makes a Foot.)

As the breadth in Inches to 144, ſo is 1 to the length in Inches. As 30 to 144 ſo is 1 to 48 Inches, or as 12 to the breadth in Inches, ſo is 12 the contrary way to the number of Inches; for if you extend the Compaſſes from 12 to 6, that extent applyed the contrary way from 12 ſhall reach to 24 the Inches required.

PROB. 7.

Having the length and breadth of an Oblong ſuperficies, to find the ſide of a ſquare equal to it.

Divide the ſpace between the length and the breadth into two equal parts, and the middle point ſhall ſhew the ſide of the Square that ſhall be equal in *area*, or quantity, to that Oblong; ſo that a Square made of 11, 32, is equal to an Oblong of 16 one way, and 8 the other way.

PROB. 8. *Of a Circle.*

Having the Diameter of a Circle, to find the ſide of a ſquare equal to that circle.

As 10000 to 8862, ſo is the Diameter 15 to the ſide of the Square 13, 29, that is equal to the Circle.

PROB. 9.

Having the Circumference of a Circle, to find the ſide of a ſquare equal to the ſame Circle.

As 10000 to 2821, ſo is the Circumference 47, 13 to the ſide of the Square 13, 29 equal to the Circle.

PROB. 10.

Having the Diameter to find the Circumference.

As 1 is to the Diameter, ſo 3142 to the Circumference. Or, as 7 to 22, ſo is the Diameter to the Circumference: or as 113 to 355.

So the Diameter being 15, the Circumference wil be about 47 13 parts

PROB. 11.

Having the Circumference to find the Diameter.

As 3142 is to 1, ſo is the Circumference to the Diameter: Or, as 22 is to 7, ſo is the Circumference to the Diameter: Or as 355 to 113.

So the Circumference being 47,13. the Diameter is 15.

PROB. 12.

To find the ſide of a ſquare that may be inſcribed within a Circle, by having the Diameter.

The Extent from 1 to 7071 will reach from the circumference to the ſide of the Square required. So the Diameter being 15, the ſide of the ſquare inſcribed will be 10, 60.

PROB. 13.

By having the Circumference, to find the ſide of the inſcribed ſquare.

The extent from 1 to the Circumference, will reach from 2251 to the ſide of the Square required.

So the Circumference being 47.13 the ſide of the inſcribed ſquare will be 10.60 as before.

PROB. 14.

Having the Diameter to find the Superficial content of a Circle.

The extent from 1 to the Diameter, being twice repeated (the ſame way) from 7854, will reach to the content required.

PROB. 15.

Having the Circumference to find the Superficial content of a Circle.

The extent from 1 to the Circumference, being twice repeated from 07958, will reach to the content.

PROB. 16.

Having the content to find the Diameter.

The extent from 1. to 1273, will reach from the content to another number, whoſe ſquare root is the Diameter required.

PROB. 17.

Having the content to find the Circumference.

The extent from 1 to 12,75, will reach from the content to another number, whoſe ſquare root is the Circumference required.

PROB. 18.

Having the content of a Circle to find the ſide of a ſquare equal to it.

Extract the ſquare root of the content by the 12 Probleme of the laſt Chapter, and that is the ſide required.

PROB. 19.

To find the content of a Circle two ways.

Multiply the Diameter by it ſelf, and multiply that product by a 11, and divide this laſt product by 14, and the quotient ſhall be the content required.

Or elſe.

Multiply half the Diameter and half the Circumference together, and the product is the content required.

PROB. 20.

How to meaſure a Circle, a Semicircle, or a quarter of a Circle, or any part that goeth to the Centre of the ſuppoſed Circle.

Firſt for a Circle.

Take half the Diameter and half the Circumference, and meaſure it then as an Oblong ſquare; for the half circle take half the Diameter, and half the Semicircumference, and do likewiſe. Thirdly, for the quarter of a Circle, take half the arch of that quarter, and the Radius or Semidiameter of the whole Circle, and work as you would do with an Oblong ſquare piece, and you ſhall have your deſire.

PROBL. 21.

How to meaſure a Triangle.

Take half the baſe, and the whole perpendicular; and work with them two, as if it were an Oblong ſquare figure, or you may take the whole baſe and half the perpendicular.

PROB. 22.

PROBL. 22.

How to meaſure a Rhombus, or a Rhomboides.

A Rhombus is a Diamond-like figure, as a quarrie of glaſs is, containing 4 equal ſides and two equal oppoſit angles; but a Rhomboïdes is a figure made of two equal oppoſite ſides and two equal oppoſit angles: and to meaſure them you muſt take any one ſide, and the neareſt diſtance from that ſide to his oppoſite ſide for the other ſide, and then reckon it as an Oblong ſquare.

PROB. 23.

How to meaſure a Trapezium.

A Trapezium is a figure comprehended of 4 unequal ſides, and of 4 unequal angles: and before you can meaſure it, you muſt reduce it into two triangles, by drawing a line from any two oppoſite corners, then deal with it as two triangles; or you may ſave ſome work thus, the line you draw from corner to corner, will be the common baſe to both triangles:

then ſay as 1 is to half the perpendiculars of both the triangles put together, ſo the whole baſe to the content.

PROB. 24.

How to meaſure a many-ſided irregular figure or Polygon.

You muſt reduce it into triangles, or to trapeziums, by drawing of lines from convenient oppoſite corners: and then the Work is all one with that of the laſt Problem.

PROB. 25.

How to meaſure a many-ſided regular figure, commonly called a regular Polygon.

Meaſure all the ſides, and take the half of the ſum of them for one ſide of a Square, and the neereſt diſtance from the center of the Polygon to the middle of one of the ſides, for the other ſide of a Square; and with them two numbers work as if it were a Square Oblong figure, and it will give the Content of the Polygon deſired.

PROB. 26.

How to reduce Feet into Yards, Ells, or other parts.

Firſt for yards, if 9 foot make one yard, how many ſhall 36 foot make.

The extent from 9 to 2, will reach from 36 to 4, for ſo many yards is 36 foot. But if you were to meaſure any quantity by the yard, as the Plaiſtering or Painting of a Houſe, then I would adviſe you to have a yard to be divided into a hundred parts, (which is as neer as commonly Workmen go to, or elſe, into a 1000, if you do require more exactneſs) and meaſure all your lengths and breadths with that, and ſet them down thus, 2. 25 (or by 1000 thus 2. 250) and the length thus 10.60, and multiply them together, and the product is the true content of that long ſquare, the like holds for ells, or poles, furlongs, or any other kind of meaſure. Again, for a yard in length, if 3 foot make one yard, then what ſhall 30 make? it maketh 10, or the contrary if 10 yards make

30 foot, what ſhall 12 make? the extent from 10 to 12, will reach from 30 to 36 foot, but if it be given in feet inches, then ſay as 9 to the breadth ſo is the length in feet and inches (or decimal parts) to the content in yards required.

CHAP. IV.

The uſe of the line of Numbers in meaſuring of land by perches, and acres.

PROB. 1.

Having the breadth and length of an oblong Superficies given in perches, to find the content in perches.

As 1 perch to the breadth in perches, ſo the length in perches to the content in perches.

Example.

As 1 is to 30, ſo is 183 to 5490 (perches.)

PROB. 2.

PROB. 2.

Having the length and breadth in perches, to find the content in ſquare acres.

As 160 to the breadth in perches, ſo is the length in perches to the content in acres.

As 160 unto 30, ſo is 183 to 34,31 (in acres and perches.)

PROB. 3.

Having the length and breadth of an Oblong ſuperficies given in Chains, to find the Content in Acres.

It being troubleſome to divide the Content in Perches by 160, we may meaſure the length and breadth by Chains, each Chain bein 4 perches in length, and divided into 100 links, then will the Work be more eaſie in Arithmetick, or by the Rule; for as 10 to the breadth in Chains, ſo the length in Chains to the content in Acres.

Example.

As 10 to 7.50, ſo is 45.75 to 34.31 (100 parts of an Acre.)

PROB. 4.

Having the Baſe and Perpendicular of a Triangle given in Perches, to find the Content in Acres.

If the Perpendicular go for the length, and the whole baſe for the breadth, then you muſt take half of the oblong for the content of the triangle, by the ſecond probleme, as 160 to 30, ſo is 183 to 34.31, or elſe without halfing, ſay as 320 to the perpendicular, ſo is the baſe to the content in acres; as 320 unto 30, ſo is 183 to 17, 15.

PROB. 5.

Having the perpendicular and baſe given in chains, to find the content in acres.

As 20 to the perpendicular, ſo is the baſe to the content in acres.

As 20 to 7,50, ſo is 45,75, to 17, 15 parts.

PROB.

PROB. 6.

Having the content of a Superficies after one kind of perch, to find the content of the ſame Superficies according to another kind of perch.

As the length of the ſecond perch, is to the firſt, ſo is the content in acres to a fourth number, and that 4th number to the content in acres required. Suppoſe a Superficies be meaſured with a chain of *66* feet or with a perch of 16½ and it contain 34. 31, and it be demanded how many acres it would contain, if it were meaſured with a perch of 18 foot? theſe kind of proportions, are to be wrought by the backward rule of Three, after a duplicated proportion: wherefore I extend the Compaſſes from 1*6*5 unto 18,0, and the ſame extent doth reach backward, firſt from 34 31 to 31.45, and then from 31. 45 to 28. 84, the content, in thoſe larger acres of 18 foot to a perch.

PROB. 7.

Having the Plot of a field with the content in acres, to find the ſcale by which it was Plotted.

Suppoſe a plain contained 34 acres 31 Centeſmes, if I ſhould meaſure it with a ſcale of 10 in an inch, the length ſhould be 38 Chains and 12 Centeſmes, and the breadth 6 Chains and 25 Centeſmes, and the content according to that dimenſion, would by the 3 Probleme of this Chapter be found to be 23,82. whereas it ſhould be 34.31, therefore to gain the truth, I divide the diſtance between 23. 82 and 34, 31 into two equal parts, then ſetting one foot of the Compaſſes upon 10, the ſuppoſed true ſcale, I find the other to extend to 12, which is the length of the ſcale required.

PROB. 8.

Having the length of the Oblong, to find the breadth of the acre.

As the length in perches to 160, ſo is one acre to the breadth in perches. As 40 to 160, ſo is 1 to 4. Again, as

50

50 to 160, ſo is 1 to 3.20, ſo is 2 to 6 40; or again if you meaſure by chains, As the length in Chains to 10, ſo is 1 acre to his breadth in Chains; as 12 50 unto 10, ſo 1 to 0. 80, or if the length be meaſured by foot meaſure, then as the length in feet unto 43560 ſo is 1 acre to his breadth in foot meaſure.

So the length of the oblong being 792 feet, the breadth of one acre will be found to be 55 foot, the breadth of 2 acres 110 feet.

The uſe of this Table is to ſhew you how many Inches, Centeſmes of a Chain, feet, yards, paces, perches, chains, acres, there is in a mile, either long or ſquare, or conſequently any of them all, in any of the other that is leſs; as for example, I would know how many Inches there is in a long perch, I look on the uppermoſt row for perches, and in the next row under, I find 198 for the quantity of inches in a long perch. But if I would know how many inches there is in a ſquare perch, then look for perch on the left hand, and in the inch colume you have 39204, for if you multiply 196 by 196, it will produce 39204.

A neceſſary Table for Menſuration of Superficial-meaſure.

	Inch.	Centeſme.	Feet.	Yard.	Pace.	Perch.	Chain.	Acre.	Mile.
Inch.	[1]	7 92	12	36	60	198	792	7920	63360
Centeſ	62 7264	[1]	1. 515	4 545	7 575	25	100	1000	8000
Feet.	144	2 295	[1]	3	5	16 5	66	660	5280
Yards.	1296	20 655	9	[1]	1 66	5 50	22	220	1760
Pace.	3600	57 485	25	8 325	[1]	3 30	13 2	132	1056
Perch.	39204	625	272. 25	90 75	10. 89	[1]	4	40	320
Chain	627264	10000	4356	1452	17424	16	[1]	10	80
Acre.	6272640	100000	43560	14520	1742.4	160	10	[1]	8
Mile.	4014489600	64000000	27878400	9292800	1115136	102400	6400	640	[1]
Squar.	Inches.	Centeſmes.	Feet.	Yards.	Pace.	Perch.	Chain	Acre.	Mile.

The like is for any other number in the whole Table, and is of very good uſe to reduce one number into another, or one ſort of meaſure into another: as inches into feet, and feet into Yards, and Yards into Perches, and Perches to Chains, and Chains into Acres, and Acres into Miles, or the contrary either long-wiſe or ſquare-wiſe: as is well known to them that have occaſion for theſe meaſures. Thus much ſhall ſuffice for Superficial meaſure, the practice of which will make it plain to any ordinary capacity.

CHAP. V.

The uſe of the line of numbers in meaſuring of Solid meaſure ſuch as Timber, Stone, or ſuch like Solids.

PROB. 1. By Foot-meaſure.

A peice of Timber being to be meaſured and not juſt ſquare, how to make it ſquare.

Divide the Space between the breadth, and the thickneſs, into two equal parts, and the Compaſſes ſhall ſtay at the ſide of the Square, equal to the oblong made of that breadth and thickneſs; which is the mean proportional between them. The breadth being 18, and thickneſs 6, the ſide of the Square will be found to be 10,38.

PROB. 2.

Having the ſide of a ſquare, equal to the baſe of any Solid given in Foot-meaſure, to find how much makes a Foot Solid in Foot-meaſure.

As the ſide of the ſquare in Foot-meaſure unto 1, ſo is 1 to a 4th number, and that 4th to the length. As 2 120 unto 1.000, ſo 1.000 unto 0, 471, and that to 0.222. or thus, the xtent from 2.120 to 1, will reach rom 1, twice repeated to 0.222, nd ſo much is the length to make a oot Solid, (at that ſquareneſs.)

PROB. 3.

To find how much in length makes a Foot, any breadth and depth without ſquaring.

As 1 to the breadth in Foot-meaſure, ſo is the depth to a fourth number, as that 4th number to 1 ſo is 1 to the lenth in Foot-meaſure.

Example.

As 1 is to 2. 50, ſo is 1. 80, to 4 50, then as 4. 50 to 1, ſo is 1 unto 0 222. the length required.

PROB. 4.

Having the ſide of a ſquare, equal to the Baſe of a Solid given, and the length thereof in Foot-meaſure, to find the content in Feet.

As 1 to the ſide of the ſquare in Foot-meaſure, ſo the length in Feet to a fourth number, and that fourth to the content in Foot-meaſure. The extent from 1 to 2. 12, twice repeated from 15.25, ſhall reach unto 68. 62.

PROB. 5.

PROB. 5.

Having the length breadth and depth of a Square Solid given in Foot-meaſure, to find the content in Feet.

As 1 to the breadth in Foot-meaſure, ſo is the depth to the Baſe in Feet; as 1 to that Baſe, ſo the length in Feet to the content in Feet.

As 1 to 2, 50, ſo 1. 80 to 4. 50, then as one 1 to 4. 50, ſo is 15.25, unto 68. 525. The content required.

PROB. 6.

By Inches, (only) and Feet and Inches. Having the ſide of a Square, equal to the baſe of any Solid given in Inches, to find how many Inches in length will make one Foot.

The ſide of the Square is found as in the firſt Problem of this Chapter, or by the 7th of Board meaſure. Then as the ſide of the ſquare in Inches to 41,57, ſo is one Foot to a 4th number, and that 4th to the length in Inches and tenth parts of an Inch.

The extent from 25,45 unto 41,57 twice repeated from 1 will reach to

2, 67, or more eaſie if it be ſquared, as the ſide of the ſquare is to 12, ſo is 12 to a 4th and that fourth to the length required. The extent from 25, 45 to 12 being twice repeated from 12, will ſtay at 2, 667, or more ſhort 267.

PROB. 7.

Having the breadth and depth of a ſquared Solid given in inches, to find the length of a Foot in Feet and Inches.

As 1 to the breadth in Inches, ſo the depth to a fourth number, which is the content of the baſe in Inches, then as this 4 number is to 1728, ſo is 1 to the length of a Foot Solid in Inch meaſure. As 1 to 21, 6, ſo is 30 to 648, then as 648 to 1728, ſo is 1 to 2, 667.

Or again thus.

As 12 to the breadth in Inches, ſo the depth in Inches to a fourth number; then as this fourth number is to 144 ſo 1 to the length of a foot ſolid; as 12 to 21, 6, ſo 30 to 54; then as 54 is to 44, ſo is 11 unto 2, 667. the length required.

Example.

The ſide of a ſquare given in inches to find how much is in a foot long. Extend the Compaſſes from 12 to the Inches ſquare the ſame extent turned the ſame way from the Inches ſquare ſhall ſhew how much is in a foot long. At 18 inches ſquare in every foot long, is 27 inches, or 2 foot 3 inches: But if the ſide of the ſquare be given in feet and parts, Say, as 1 to the feet and parts ſquare, ſo is that to the quantity in 1 foot long, which multiplyed by the feet long gives the whole content.

PROBL. 8.

Having the ſide of the ſquare and the length thereof given in Inch-measure, to find the content in Feet.

As 41.57, to the ſide of the ſquare in Inches, ſo is the length to a fourth Number, and that fourth to the content in Foot-meaſure. As 41. 57, to 25. 45, ſo 183, twice repeated unto 68, 62.

PROB. 9.

PROB. 9.

Having the ſide of a Square equal to the baſe of any ſolid given in Inch-meaſure and the length in Foot-meaſure, to find the content in Feet.

As 12 to the ſide of the ſquare in Inches, ſo the length in Feet to a fourth Number, and that fourth to the content in Foot-meaſure. As 12 to 25,45, ſo 15. 25 to 32. 55, and 32. 55 to 68. 62. Or the extent from 12 to 25, ſhall reach to 68. 62, the content ſought.

PROB. 10.

Having the length, breadth and depth, of a Squared Solid given in Inches, to find the content in Inches.

As 1 to the breadth in Inches, ſo the depth to the baſe, then as 1 to the baſe, ſo the length to the content in Inches. As 1 to 21. 6, ſo 30 to 648: as 1 to 648, ſo that 183 to 118584.

PROBL. 11.

Having the length, breadth, and depth given in Inches, to find the content in Feet.

As 1 to the breadth in Inches, ſo the depth in Inches to the baſe in Inches; Then as 1728 to the baſe, ſo is the length in Inches to the content in Feet. As 1 to 21, 6, ſo 30 to 648, as 1728 to 648, ſo 183 to 68. 62.

Or you may ſay,

As 12 to 21.6, ſo 30 to 54, as 144 to 54, ſo 18, 3 to 68. 62.

PROB. 12.

Having the breadth and depth of a ſquared ſolid given in Inches, and the length in Feet, to find the content.

As 1 to the breadth in Inches, ſo the depth in Inches to a fourth number. Then as 144 to that fourth, ſo is the length in Feet to the content in Feet.

As 1 to 216, ſo is 30 to 648; then as 144 to 15. 25, ſo is 648 unto 68. 62, Or as 144 to 21. 6, ſo 30 to 4. 50: as 1 to 4. 50, ſo 15. 25 to 68. 62. Or again, As 12 to 21. 6, ſo 30 to 54 : then as 12 to 54, ſo 15.25 to 68. 62, the content required.

CHAP. VI.

The Uſe of the Line of Numbers in meaſuring of Cylinders, by Foot-meaſure.

PROB. 1.

Having the Diameter of a Cylinder given in Foot-meaſure, to find the length of a Foot-ſolid in Foot meaſure.

As the Diameter in Feet to 1. 128, ſo is 1 to a fourth, and that fourth to the length in Foot-meaſure.

The Extent from (the Diameter) 1. 25; to 1. 128, being twice repeated from 1, will reach to 8. 148, the length ſought.

To find how much is in a foot long at any Diameter given.

Say, As 1. 128 to the feet and parts in Diameter, So is 1 to a 4th.

and that 4th. to the feet and parts in one foot long.

PROB. 2.

Having the circumference given in Foot-meaſure to find the length of a Foot ſolid in Foot-meaſure.

As the Circumference in Foot-meaſure is 3. 545; ſo is 1 to a fourth, and that fourth to the length ſought.

As 3 *f* 927 *p* unto 3.545, ſo is that diſtance twice repeated from 1 to 0, 815 the length of a Foot-ſolid.

The Circumference given to find how much is in a foot long at that compaſs, as 3, 545 to the feet about, the ſame extent applyed twice the ſame way from 1 ſhall reach to the quantity in one foot long. At 5 foot about one foot in length, is two foot neer in the content, which multiplyed by the feet long gives the whole content.

PROB.

PROB. 3.

Having the Diameter and length of a Cylinder given in Foot-meaſure, to find the content in Foot-meaſure.

As 1.128 to the Diameter in Foot meaſure, ſo is the length in Foot-meaſure to a fourth, and that fourth to the content in Foot-meaſure.

The Extent from 1.128 to 1.25. being twice repeated from 8.75, will reach to 10.737, the content ſought for.

PROB. 4.

Having the Circumference and length of a Cylinder given in Foot-meaſure, to find the content in Foot-meaſure.

As 3.545 to the Circumference in Feet, ſo is the length in Feet to a fourth, and the fourth to the content in Foot-meaſure.

The Extent from 3.545 to 3.927, being twice repeated from 8.75, will reach to 1074, the content in Foot-meaſure.

PROB. 5.

PROB. 5. By Inch-meaſure.

Having the Diameter of a Cylinder given in Inches, to find how many Inches makes a Foot-ſolid.

As the Diameter to 46.90, ſo is 1 to a fourth number, and that fourth number to the length in Inches.

The Extent from 15 to 46.90, will reach from 1 (being twice repeated) to 9.778, the length ſought.

PROB. 6.

Having the Circumference given in Inches, to find the length of a Foot-ſolid.

As the Circumference to 147.36 ſo is 1 to a fourth number, and ſo that fourth to the length in Inches.

The Extent from 47.13, to 147.36, being twice repeated from 1, will reach to 9.78, the length ſought.

PROB. 7.

Having the Diameter and length given in Inches, to find the content in Inches.

As 1 128 to the Diameter in Inches, ſo is the length to a fourth, and that fourth to the content in Inches. The extent from 1 128 to 15, being twice repeated from 105, will reach to 18555, 34 the content in Inches.

PROB. 8.

Having the Circumference and length given in Inches, to find the content in Inches.

As 3,545 to the Circumference in Inches, ſo is the length in Inches to a fourth number, and that fourth to the content in Inches. The extent from 3,545 to 47,13, being twice repeated from 105 will reach to 18555 the content in Inches.

PROB. 9. *By Feet and Inches.*

Having the Diameter given in Inches and the length in Feet to find the content in Feet.

As 13, 54 to the Diameter, ſo the length to a fourth number, and that fourth to the content in Feet. The extent from 13, 54 to 15, being twice repeated from 8,75 will reach to 10, 74, the content ſought for.

PROB. 10.

PROB. 10.

Having the Circumference given in Inches, and the length in Feet-meaſure to find the content in Feet.

As 42,54 to the Circumference in Inches, ſo is the length in Feet to a fourth, and that foutth to the content. The extent from 42, 54 to 47, 13; being twice repeated from 8,75, will reach to 10, 74 the content ſought.

PROB. 11.

It being an ordinary way in meaſuring of round Timber, ſuch as Oake, Elme, Beech, Pear-tree, and the like, (which is ſometimes very rugged, and uneven, and knotty) to take a line and girt about the middle of it, and then to take the fourth part of that, for the ſide of a Square equal to that Circumference: But this meaſure is not exact, but more then it ſhould be. But either becauſe of allowance for the faults abovesaid, or for Ignorance, the cuſtome is ſtill uſed, and men commonly think themſelves wronged if they have not ſuch meaſure. Therefore I have fitted you with a proportion for it both for Diameter and Circumference.

And firſt for the Diameter.

The Diameter given in Inches and the length in Feet, to find the content.

As 1,526 to the Diameter, ſo is the length to a fourth, and that fourth to the content in Feet: according to the rate aboveſaid.

The extent from 1. 526 to 9. 53, being twice repeated from 8, ſhall reach to 3. 12, the content.

PROB. 12.

Having the Circumference in Inches, to find the content in the aboveſaid meaſure.

As 48 to the Inches about, ſo is the length to a fourth number, and that fourth to the content. The extent from 48 to 30, being twice repeated from 8, ſhall fall upon 3. 12, the content required.

PROB. 13.

PROB. 13.

How to meaſure Taper Timber, that is bigger at one end than at the other.

The uſual way for doing of this, is to take the Circumference of the middle or mean bigneſs, but a more exact way, is to find the content of the baſe of both ends and add them together; and then to take the half for the mean, which multiplyed by the length, ſhall give you the true content.

Example.

A round Pillar is to be meaſured, whoſe Diameter at one end is 20 Inches, at the other end it is 32 Inches Diameter, and in length 16 Foot (or 192 Inches) the content of the little end is 314. 286, the Area or content of the greater end is 773, 142, which put together make 1087, 428, whoſe half 543,714. multiplyed by 192 the length, gives 104393. 143. Cubical Inches which reduced into Feet, is 60 Foot, and 713 cubical Inches, for the ſolid content of the Pillar.

PROB. 14.

PROB. 14.

To mevſure a Cone, ſuch as is a Spire of a Steeple, or the like by having the height and Diameter of Baſe.

Example; let a Cone be to be meaſured, whoſe baſe is 10 Foot, and the height thereof 12 Foot, the content of the baſe will be found, by the 14 Problem of Superficial meaſure, to be 78,54, Then this 78,54 multiplyed by 4, a third part of 12, the perpendicular or height of the Cone will give 314,4, for the content of the Cone required: By the numbers work thus, the extent from 1 to 4, will reach from 78,54 to 314,4. But becauſe there may be ſome trouble in getting the true perpendicular of a Cone, which is its height, take this rule; Firſt, take half the Diameter, and multiply it in it ſelf, which here is 25, then meaſure the ſide of the Cone 13, and multiply that by it ſelf which here is 169, from which take the Square of half the Baſe, which is 25, your firſt number found, and the remain is 144, the Square root of which is the height of the Cone, or length of the perpendicular.

PROB. 15.

To meaſure a Globe or Sphere arithmetically.

Cube the Diameter, then multiply that by 11, and divide by 21, gives you the true ſolid content; let a Sphere be to be meaſured whoſe Axis or Diameter is 14, that multiplyed by it ſelf gives 196, and 196 again by 14 gives 2744, this multiplyed by 11 gives 30184, and this laſt divided by 21 gives 1437.67, for the content of the Sphere whoſe Diameter is 14. But more briefly, by the numbers thus, The extent from 1 to the Axis, being twice repeated from 3. 142, will reach to the Superficial content, that is, the Superficies round about. But if the ſame extent from 1 to the Axis be thrice repeated from 5238, it will reach to the ſolid content; as 1 to 14, ſo 3. 142 to 617. being twice repeated, as 1 to 14, ſo 5278 to 1437.

being thrice repeated. As for many ſided figures if they have length, you have ſufficient for them in the Chapter of Superficial meaſure, to find the baſe, and then the baſe multiplyed by the length giveth the content. But as for figures of roundiſh form, they coming very ſeldom in uſe, I ſhall not in this place trouble you with them, for they may be reduced to Spheres or Cones, or Triangles, or Cubes, and then meaſured by thoſe Problems accordingly. And ſo much for the menſuration of Solids.

CHAP. VII.

Of Gaging of Veſſells.

The Uſe of the Line of Numbers in Gaging of Veſſels.

The Art of Gaging all manner of Veſſels either cloſe or open.

All Veſſels to put Liquor in are

made either ſquare, as Brewers Coolers; or round, or oval-formed, or mixed, as part of one form and partly of another: but the ordinary veſſels are the regular, *viz.* Square-backs, or Coolers, or Taper-Tuns, and Coppers; or elſe cloſe Cask, as Barrells, Buts, Hogſheads, and the like; for which there are particular Rules for the performance thereof.

And firſt for the Square-backs.

In order hereunto you muſt conſider by what meaſure you would Gage your veſſel as to Dimenſions taking, and as to the ſolid content either in Wine or Ale-meaſure, or Ale or Beer-Barrels.

Now the common and moſt received meaſure to take dimenſions with, is Inches, and 100 parts of an Inch, or 10 parts at the leaſt, and for Brewers Buſineſſes the Ale-Gallon is only in uſe and no other.

Note, An Inch is the exact 36th part of a Standard-yard, and an Ale-gallon is 282 $\frac{1}{4}$ of thoſe Inches taken

cubically,

cubically, which is agreeable to four of the Ale-Quarts in the King's Majeſties Exchequer: Or if you will 288 cubique Inches, which is agreeable to the Standard-Gallon in *Coopers Hall*, as Alderman *Starling* and others have much contended for; but in regard that 282 $\frac{1}{4}$ is according to the Ale-quart in the Exchequer, that I ſhall the rather uſe.

		contains of Cube Inches
Gallon contains inch.	282 $\frac{1}{4}$	282 $\frac{1}{4}$
18 *g*	$\frac{1}{2}$ Bar. of Beer	5080 $\frac{1}{2}$
16 *g*	$\frac{1}{2}$ Bar. of Ale	4516
36 *g*	Barr. of Beer	10161
32 *g*	Barr. of Ale	9032

At 288 Inches in a Gallon.

		$\frac{1}{2}$
Gallon contains Inch.	288	
Barrel of Beer	10368	5184
Barrel of Ale	9216	4608

Note, A Beer-Barrel is juſt 6 Cubique-foot.

This being premiſed, then to meaſure any Square back, it is but to take the length and breadth exactly in Inches and 10 parts, and multiply them together, and then to multiply that product, by the depth in Inches and 10 parts, which laſt product is to be divided by 282 to bring it to Gallons, or by 10161 to bring it to Beer Barrels, or 9032 to bring it to Ale-Barrels; as in the following Example.

A Back or Cooler is 72 Inches and 6 tenths broad, and 365 Inches and 4 tenths long, and 8 Inches 7 tenths deep, how many Gallons or Barrels will it hold? Note the work.

```
       72 6
      365.4
   ---------
      290.4
     3630
    4356
   2178
 ----------
   26528|04
        87
 ----------
  1856963 8
 2122243 2
 ----------
 230793|948
```

230794 the Content in Cube inches.

~~32~~ 1
~~5373~~2
~~7617~~4 *gallons* *inches*
~~230794~~(818——124
~~28222~~
~~288~~
~~2~~

2
~~73~~5
~~2857~~2 *barrels* *inches*
~~230794~~(22——7252
~~1010611~~
~~1016~~

Viz. 22 barrels and neer 26 gallons.

To work this by the Line of Numbers will be very difficult to come to exactneſs, becauſe we cannot ſee to above 4 figures, yet in regard that after the whole operation is done, the grand querie is, How many Barrels is there? and not how many Inches or Gallons; and this you may wel well perform to a quarter of a Barrel, by the Line of Numbers. I conceive it will be as much uſed as the Arithmetical way, being 10 to 1 ſooner done; which is thus,

Extend the Compaſſes from 1 to the Inches and 10ths. broad; the ſame Extent applyed the ſame way from the Inches and 10ths. long, ſhall reach to a fourth number.

Again, As 10161 (the Cube Inches in a Beer-Barrel) to the 4th. or the extent from 10161 to the 4th. ſhall reach from the Inches and 10ths deep to the content in Beer-Barrels.

Example as before.

As 1 to 72. 6. the breadth of a Cooler, ſo is 365. 4 the length to a fourth number, 26528. Again, as 10161, to the fourth laſt found. So is 8. 7 the depth, to 22. 70, that is 22 Beer Barrels, and above a half, or 26 Gallons.

If you would know how many Ale Barrels, or Kilderkins, or

Gallons, then make uſe of the reſpective numbers of Inches in thoſe meaſures as in the Table.

This is a very quick neat way for all Square Veſſels.

	The Siſe of Beer Veſſels.				
	Names.	*Head*	*Bung*	*Len.*	*Gall.*
Beer Veſſels.	*Barrell*	20.2	22.7	27.7	36
	Kilderkin	16.2	18.0	22.0	18
	Firkin	12.7	14.3	17.4	9
	Pin	10.1	11.4	13.9	4 ½
	½ Pin	08.0	09.0	11.0	2 ¼
Ale Veſſels	*Barrell*	19.4	21.8	26.6	32
	Kilderkin	15.4	17.3	21.2	16
	Firkin	12.2	13.7	16.8	08
	Pin	09.7	10.9	13.3	04
	½ Pin	07.7	08.7	10.6	02

The

Gage Points and Fixed Numbers.

The Inches in a Gallon for Wine, Ale, and Corn-measure.

231	17.1485 Wine
272¼	18.6168 Corn
288	19.1480 }
288¾	19.1716 }
282	18.9468 Ale

Inches in these measures following.

Beer.	Bar.	10161	35.96
	K.	5080½	
	F.	2540	
	P.	1270	
Ale.	Bar.	9032	33.91 *gage point*
	K.	4516	
	F.	2258	
	P.	1129	
	Gall	0282¼	

at	288	to a Gallon.
9216	Bar.	10368 or 6 foot
4608	K.	5184
2304	F.	2592
Ale	Gal.	288

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To Gage any round Tun.

Firſt, If it have equal Diameters at the Top and Bottom, then it is meaſured as a Cylender, and the proportion between a Cube and a Cylender is as 11 to 14 and the contrary, ſo that a Cylender 12 Inches high and 12 Inches Diameter, is equal to $\frac{11}{14}$ of a Cube 12 Inches every way.

Or in Numbers, as 1728, to 1358 *ferè.*

Or elſe meaſure it by this Analogy.

As 1 to 0. 7854, ſo is the Square of the Diameter multiplyed by the depth to the ſolid Content in Inches: Note the Work.

Diameter 60 Inches, Depth 36 Inches.

```
      60
      60
    ------
    3600 ſquared
    36
   -------
   21600
  19800 mult by depth
 ---------
 129600
```

129600
0.7854

518400
648000
1036800
907200

101787(8400 ſolid inches.

Then divide this laſt Product by 282, and you ſhall have the Content in Ale Gallons, or by 10161, and then you have it in Beer Barrels, or by 4516 for Ale-Barrels, as before in the Table of Cube Inches in thoſe meaſures.

1
153
4716 *gallons* *inches*
101788(360——268
28222
288
2

Or elſe you may ſhorten the work, and ſave this laſt Diviſion thus, and bring it into Gallons or Barrels.

After you have multiplyed the Diameter by it ſelf, which is called Squaring, and then multiplyed that Product by the Inches and 10ths. deep. Note this laſt Product, for if you would bring it into Gallons, then multiply it by .002785, but if you would have it at firſt into Barrels, then multiply it by .0000775, and the product cutting off the fractions, ſhall be the Gallons, or Barrels of the content required. Note the work.

129600
0.2785

648000
1036800
907200
259200

360|936000
Gallons.

129600
0.0000775

648000
907200
907200

10|0440000
Barrells.

The only difficulty in this Work is to know how many figures is to be cut off from the laſt Work, the beſt Guide wherein is experience, for one that is experienced will hardly call a Veſſel of 10 Gallons a 100, nor the contrary, nor one of a 100 a 1000, or the contrary, much leſs 10; now if you work right the miſtake muſt be ſo much or none. For 360 Gallons muſt needs be more then one Barrel, and yet not a 100, therefore it muſt needs be 10, and the reſt cut off, as the 100 thouſand part of a Barrel.

But to apply this to the Line of Numbers, for which chiefly my aim is, the whole work is thus.

Extend the Compaſſes from 1 to the inches Diameter, the ſame Extent ſhall reach from thence the ſame way to the product.

Then the extent from 1 to the laſt Product ſhall reach from the inches deep the ſame way to another product which is the Square of the Diameter, multiplyed by the depth; which obſerve and note. Then laſtly, the extent from 1 to 0. 2785 for Gallons, or to 0.775 for Barrels, ſhall reach the ſame way from the laſt found product (or the Square of the Diameter multiplyed by the length) to content in Gallons or Barrels required.

Example.

As 1 to 60 the Inches in Diameter ſo is 60 to 3600: Again, as 1 to 3600 ſo is 36 the inches deep to 129600, the Square of the Diameter multiplyed by the depth in Inches.

Then laſtly, firſt for Gallons ſay, as 1 to 0.2785, ſo is 129600 to 361 *fere*, or elſe, if you pleaſe, to Barrels.

As 1 to 0. 775 ſo is 129600 to 10 Barrels, and a little more.

This Rule is for all Cylender-like round Veſſels, but if the ſides be ſtreight and taper, then the uſual way and ſomewhat neer the Truth is, to add the Diameters at the top and bottom together, and to take the half for the mean Diameter, which when you have got, work as before.

Or elſe you may make uſe of the Gage-point, according to Mr *Gunter*'s way, which by Arithmatick is thus;

Multiply the mean Diameter by the length, and then divide that product by 17.15 for Wine-meaſure, or by 18.95 for Ale-meaſure, and note the Quotient and his Remainder; Again, Multiply the quotient laſt found, by the mean Diameter, and the Product; divide again by 17--15 for Wine, or by 18.95 for Ale, and the Quotient ſhall be the Content in Gallons.

This way by the Line of Numbers is very quick and ready. Thus;

Extend the Compaſſes from the Gage-points either 17.15 for Wine, or 18.95 for Ale, to the mean Diameter, the ſame extent being turned twice the ſame way from the length, ſhall reach to the content in Gallons.

The Extent from 18-95 to 60 being twice repeated from 36, the Inches deep ſhall reach to 361 *ferè*, the content in Ale Gallons.

Or if you would have it to Beer-Barrels, then ſay, as 35. 96 the Gage point for a Beer-Barrel is to the mean Diameter 60, the ſame extent applyed twice the ſame way from the length, ſhall reach to 10. 002, that is, 10 Barrels.

The Gage-point for an Ale Barrel which contains but 32 Gallons is 33. 91.

PROB. 1.

The true content of a Solid meaſure being known, to find the Gage point of the ſame meaſure.

The Gage-point of a Solid meaſure is the Diameter of a Circle, whoſe Superficial content is equal to the Solid content of the ſame meaſure; ſo the Solid content of a Wine Gallon, (according to *Wincheſter* meaſure) being 231 Cube Inches, if you conceive a Circle to contain ſo many Inches, you ſhall by the 16 Problem of board meaſure find the Diameter thereof to be 17. 15, for as 1 is to 1. 273, ſo is 231 to 294. 1, whoſe ſquare root by the 12 of the ſecond, is 17. 15, the Gage-point for Wine meaſure.

Thus likewiſe you may diſcover the Gage point for Ale-meaſure, an Ale-Gallon (as hath been of late diſcovered) containing 282 Cubique Inches. For as 1 is to 1. 273, ſo is 282 to 356. 3, whoſe ſquare root (by the 12 Problem of the ſecond Chapter) is 19. 95, the Gage-point of Ale meaſure, becauſe of ſoil and waſt exceeding that of wine above 2 Inches.

Another way by having the Diameter, length, and true content of any Veſſel.

Extend the Compaſſes on the line of numbers to half the diſtance between the content and length of the Veſſel, the ſame extent will reach from the Diameter to the Gage-point.

Example.

Here at *London* it is ſaid, that a Wine Veſſel being 66 Inches in length, and 38 Inches in the Diameter, would contain 324 Gallons; if ſo, we may divide the ſpace between 324, and 66, into two equal parts, the middle will fall about 146, and the ſame extent that reacheth from 324 to 146 will reach from the Diameter 38 unto 17. 15, the Gage-point, for a Gallon of Wine or Oyl after *London* meaſure. The like reaſon holdeth for the like meaſure in all places. Now from what hath been ſaid doth neceſſarily follow this concluſion: that when the Diameter of a Cylinder in Inches, is equal to the Gage-point of any meaſure, given likewiſe in Inches; every Inch in the length thereof, contains one integer of the ſame meaſure. So in a Cylinder 17. 15, Inches Diameter, every Inch in the length thereof, contains one intire wine Gallon, and in a Cylinder of 18. 95 Diameter, every Inch is one intire Ale Gallon.

PROB. 2. To find the equated Diameter two ways first by Arithmetick, as in Problem 8 of the ſecond Chapter.

Add the two Diameters at head

and bung together, (being meaſured in Inches) and the half ſum keep. Secondly, Subſtract the Diameter of the head out of the Diameter at the bung, and note the remainder, which is to be divided by 4, or $4\frac{1}{2}$ (as by the number 5 is eaſie) to find out a fourth (or ſomewhat leſs) part of the difference. Thirdly, that fourth part (or ſomewhat leſs) is to be added to the half ſum kept, to make up the mean Diameter ſought. *Examp.*

A Veſſel hath in Diameter at the head 18 *in.* 3 *p.* and at the bung 21.5 Inches, I would know the mean Diameter 18.3, and 21.5 added, is 39.8, the half is 19.9, the leſs taken from the greater, the remainder is 3 *in.* 2 *p.* which brought or reduced into 100 is 320. and in ſtead of dividing by 4 or $4\frac{1}{2}$ ſay 45, and the product is 7 tenths and 3 over; which 7 tenths add to 19.9, and it maketh 20.6 tenths for the mean Diameter required to be found.

Another way by Geometry and ſomewhat more exact, Of the Diameter at the head, and bung, take the difference, then ſay as 1 is to 7, ſo is the difference to a fourth ſum, which fourth ſum is to be added, to the leaſt of both the Diameters, *viz.* that at head, as in the former example 18.30 and 21.50 added is 39.80, whoſe half is 19.90. and the difference is 3 *in.* 2 *p* or 320, then ſay, as 1 is to 7, ſo is 320 to 2.24, which 2.24 if you take with your Compaſſes, out of your Scale of Inches and add it to 18.30, you ſhall ſee it reach to 20 Inches 54 parts, and this is the true mean Diameter, to make it a perfect Cylinder; or if you add 2 Inches 24 to 18.30, it makes it 20.54 as before.

Note, If the difference of the two Diameters be much, then you muſt add the 100 parts as in the Table annexed.

A Table.

Dif. in	*parts 100*
02	003
03	005
04	090
05	012
05	015
07	019
08	023
09	026
10	030
11	035
12	040
13	047
14	055
15	063
16	070
17	076
18	083
19	090
20	100
21	112
22	126
23	140
24	155
25	170

This Table is thus uſed when the difference between the head and bung in cloſe Cask is above 4 inches; thus,

As 10 to 7. ſo is the difference between the head and bung augmented by the 100 parts of an Inch, as in the Table, to the fourth number, which you muſt add to the Diameter at the head, to get a mean Diameter.

PROB. 3.

Having the mean Diameter, and the length of a Veſſel, to find the content.

Extend the Compaſſes from the Gage-point to the mean Diameter, the ſame extent being twice repeated from the length, ſhall give the content in galons and 100 parts.

Example.

As 17. 15 to 20, ſo is 25 to 34, being twice repeated.

Again, in a leſſer Veſſel.

As 17. 15 to 16, ſo is 23 to 20, being twice repeated from 23 the ſame way as from 17. 15 to 16.

PROB. 4.

Having the Diameter and Content, to find the length.

Extend the Compaſſes from the Diameter to the Gage-point, the ſame extent twice repeated from the content, ſhall give the length.

As 38. to 17. 15, ſo is 324 to about *66* twice repeated.

PROB. 5.

Having the length and content, to find the Diameter of a Veſſel.

Extend the Compaſſes to half the diſtance, between the length and content, the ſame extent ſhall reach from the Gage-point to the Diameter.

Divide the ſpace between *66*, and 324, in two equal parts, the ſame extent ſhall reach from 17. 15 to 38, the Diameter aboveſaid.

Example.

As 10 to 7, ſo is the Difference 10 *in.* and 3 10th more, as in the Table to 7 Inches 2 10th, which you muſt add to the Diameter at head, to make a mean Diameter.

PROB.

PROB. 6.

Having meaſured a Veſſel according to Wine meaſure, to know what it holds in Ale meaſure, without knowing the Gage-point.

As 282 is to 231, ſo is the content in wine Gallons, to the content in Ale Gallons. Or the contrary, as 231 is to 282, ſo is the content in Ale Gallons, to the content in wine Gallons.

Example.

As 282. to 231, ſo is 116. 4, to 95, 30. and as 231 to 282: ſo is 95. 30, to 116. 4, &c.

PROB. 7.

To meaſure any veſſel a more eaſie way.

There is yet a more eaſie way, and for exactneſs no way inferior to any extant, and that by taking the length in Inches and 10 parts, but the Diameters at head and Bung, with a line called *Oughtred's* Gage line, (and to be had at *John Brown's* houſe in the *Minories* neer *Aldgate*, Mathematical-Inſtrument-maker) the uſe of which is thus, take the Diameter at the bung, with thoſe diviſions on the line aforeſaid, from that end where the diviſions begin to be numbred. And ſet that down twice: and the Diameter of the inſide of the head (for ſo we underſtand all along,) and ſet that down once. In this manner.

0|63 and then add them together as
0 53 here you ſee, the length in In-
0 51 ches ſuppoſe to be (30. 82.)
1|77 Thirty and eighty two of a
hundred: then ſay, As 1 is to 1. 77, ſo is 30. 82 to 54. 55 hundred parts of a Gallon, being a little more then half a Gallon, which is 54 gallons ½ the content of a high Country Hogſhed, whoſe meaſures were as before.

Depth ————————-43-60

Diam. at top ————---72-33
Diam. at bottom ——— 58-16

Sum of the Diameters 130-49
130.49

117441
52196
00000
The Summe of 39147
the Diameters 13049

Squared———- 17027|6401
Product of Diam. 4206|7128
The Residue 12820|9273

72.33
58.16

43398
7233
57864
36165

4206|7128

The reſidue the fraction cut of

12821
4360
———
769260
38463
51284
———
558995|60

~~0~~
~~0~~ 3
~~1079~~
~~2342~~3 $\quad\quad\frac{33}{1077}$
~~55~~8~~996~~(519
~~107777~~
~~1077~~
~~10~~

To make the Number 1077 which is fixed for an Ale-Gallon, or 882 for a Wine Gallon, or the fixed Number for a Beer-Barrel which is 38796, for an Ale Barrel is 34485.

Multiply the Cube Inches in a Gallon or Barrel by 14, divide the Product by 11, and multiply the quotient by 3, produceth theſe fixed Numbers.

To meaſure a Taper, round Tun by Arithmatick.

Set down the Diameters of the top and bottom in Inches and 10 parts, and add them together to get the ſum, and multiply the one into the other, to get the Product of the two Diameters.

Alſo multiply the ſum of the Diameters in it ſelf, which is called Squaring thereof.

Then ſubſtract the product of the two Diameters, out of the Sum of the two Diameters ſquared, and note the Reſidue for one number; then multiply that reſidue by the Inches deep, which produceth another product, which laſt Product divided by a 1077, a certain fixed number for Ale Gallons, ſhall in the quotient give the content in Alegallons required. Note, That if the figures be many, becauſe of Fractions, you may cut off all the Fractions after the firſt

Multiplication, which are always as many as the 10's or 100 parts of the Inch come to in both Sums, as you may ſee in the Example annexed.

To work this by the Line of Numbers: Extend the Compaſſes from the fixed Number, to the ſquare of the two Diameters, leſs by the product of the two Diameters multiplyed together, the ſame extent will reach from the perpendicular depth to the content in Gallons or Barrels, according as the fixed number was.

Example. As 1077 to 12821, ſo is 43. 60. to 519. 10 gallons; as 38796 to 12821, ſo is 43. 60. to 14. 40 Barrels; as 34485 to 12821, ſo is 43. 60. to 16.22 Barrels of Ale, and the like for any other meaſure.

Example of this way.

Diam. Head, 18 *Bung,* 32 *length,* 40 *Inches.*

18
18

144
18

324
324

3564

~~2~~
~~172~~8   ~~1~~2
~~3564~~ (~~25~~4-6(84.9.1 third of the
~~1444~~   ~~33~~   (head
~~11~~

32
32

64
96

1024
1024

11264

~~3~~0~~2~~ 8   ~~22~~
~~112~~64(8~~04~~6(268.2
~~1444~~ ~~33~~   268 2
~~11~~   849

621.3
1   40
~~3~~ 3
~~174~~ 5   24852|0
~~24~~8~~52~~ (107-58 *gallons of wine.*
2~~3111~~
~~233~~
~~2~~

Or ſhorter thus:

As 1 to 0.5236 ſo is 1024 to 535.5
As 1 to 0.2618 ſo is 324 to 84.9

621.4
40

Cube-Inches 24856|0

Another way more exact but yet more tedious to work. Note the foregoing Example.

Meaſure the two Diameters in Inches and 10 parts, and alſo the length

within,

within, and find out the Superficies of the Circles having thoſe Diameters, and add two third parts of the greater Diameter, and one third part of the leſſer into one ſumme; Then multiply that number by the length, and the product ſhall be the content in Cube Inches, which product divided by 282 gives Ale-gallons or by 231 gives the content in Wine-gallons.

To find the content of a Circle having the Diameter, ſquare the Diameter, then multiply that ſquare by 11, and divide the laſt product by 14, and the quotient is the ſuperficial content in Inches required.

Or ſhorter thus,

As 1 to 0.5236 a number fit fo 2 thirds. So is the Square of Diameter at bung to a fourth. Then, as to 02618 a number for 1 third o head; ſo is the Square of Diameter a head to another fourth: which tw fourth added together and multiplye by the length, gives the content i

Cub

Cube Inches. Then thoſe divided by 231 for Wine, or by 282 for Ale, gives the content in gallons.

The uſe of ſeveral Gaging-lines.

Laſt of all to make this work more eaſie for Mechanick men, and thoſe that want Arithmatick, there is ſeveral lines to be had on Joint or ſtreight rules at the *Sphere* and *Dial* in the *Minories.* As firſt, a Diagonal-line for Wine or Ale-gallons. Second, by Mr. *Oughtred's* Gage line ſeveral wayes applyed. Thirdly, Rules to find the emptineſs of Buts, Barrels, and Kilderkins. Fourthly, a Rule to Gage any Buſhel, Half-Buſhell, Peck, Half-peck, Pottle, or Quart, or Pint meaſure, according to 272 the Corn-gallon; Whoſe ſeveral uſes is as followeth.

Firſt, for the Diagonal line.

Put the Rule in at the Bung-hole down aſlope to the bottom of the head, and obſerve what parts the middle of the Bung-hole cuts, which a putting both ways will aſſure you of, and ſo many Gallons will the Veſſel hold, (when full) of Wine or Ale-Gallons, according as your Line is.

Example. Suppoſe the length of the Diagonal-line aſloop from the bottom at the head, to the middle of the Bunghole be 28 inches, then on the Diagonal Line for Wine-meaſure, you ſhall find almoſt 60 gallons; and on that for Beer or Ale-meaſure but 48 gallons; for the content of ſuch a Veſſel whoſe ſlope or Diagonal line from the middle of the Bung-hole to the head at Bottom is 28 Inches.

Note alſo, This Diagonal line will ſerve to meaſure Pots, Pails, Kettles, and ſuch like Veſſels that be made open; Provided, that when you take the Diagonal-line from the upper edge of the Veſſel to the oppoſite lower edge acroſs, next the bottome, whatſoever the edge of the Veſſel cuts on the rule, the half thereof is the content of the Veſſel neer the matter.

Example.

Example.

Suppoſe that a Croſs from the upper edge of a Paile to the bottom be 18 Inches, the Rule will ſhew 16, the half of it is 8, the number of Gallons the Pail holds.

The uſe of Mr. *Oughtred's* Gage-line you have in part before for meaſuring of Wine or Oyl cloſe Cask, but for the application thereof to Brewers-Tuns, or indeed any great or ſmall Veſſel is thus, All along by the Gage line is a line of ſmall Inches, about half an inch in bigneſs, and every of thoſe parted into 10 parts, to repreſent 10 parts of an Inch, and the uſe is thus;

Take the Diameters of your veſſel at the top and bottom in Inches and 10 parts, and add them together, then if the ſides are ſtreight, count the half for a mean Diameter: But if the Staves are ſwelling outwards, then uſe the proportion before as 10 to 7, to find the mean Diameter.

Thus having found the mean Diameter, look for the ſame on the ſmall Inches, and there you ſhall have the true quantity of Ale-gallons in one Inch deep; which number if you multiply by the Inches deep, the product ſhall be the content in Ale-Gallons.

Example.

Suppoſe a Brewers Tun at the Top be 82 *in.* at bottom 72, and deep 38 Inches.

Diameters { 82-00 *top*
{ 72-00 *bottome.*

154-00 *Sum*

77-00 *half ſum or mean Diameter.* Then if you look for 77 among the ſmall Inches, you ſhall find right againſt it 16 Gallons, and 49 or neer a half, which multiplyed by 38, the inches deep, make 626 Gall. 62 parts for the extent on the line of numbers, from 1 to 16-49 ſhall reach the ſame way from 38 the Inches deep to 626 ½ the content.

Note, That by this Rule you may

make a Table of the content of any round taper Tun, of how much ſhall be in or out at any number of Inches of fulneſs or emptineſs.

Another *Example*. Suppoſe a Veſſel be in Diameter at top 160 Inches 5 tenths, and at bottom 148 Inches and 8 tenths, the ſum is 309-3 the half is 154-6½ for a mean Diameter, the Gage-line right againſt 154-6½ is 64. 63, which multiplyed by 41.70, the Inches and tenths deep make 2695|0710, which laſt 4 figures are fractions and parts of a Gallon.

Note, If in a great quantity of gallons, if this way prove to be ſomewhat leſs then in truth there may be, or that it do not agree with the former Rules; take this for anſwer, it is as neer as any ſuch inſtrumental way can be compoſed, and of two errors take the leaſt, and therefore may pleaſe till a better comes. Note alſo, That by altering the Inches that goes by the Gage-line it may be made fit for Ale or Beer-Barrels, or any other greater or leſſer meaſure whatſoever, and the error allowed for by taking the Diameters more exactly, as experience and practice will make eaſie.

Note alſo the ſame Line is improved by Mr. *Newton* I think, but the way how being in Print in *Wingate*'s Rule of proportion, I ſhall ſay nothing to it, this way being full as exact and more eaſie.

The Uſe of the Rule to find the emptineſs of Buts, Barrels or Kilderkins.

The uſe hereof is very eaſie, for if you put the beginning end of the Rule downright at the bunghole home to the oppoſite ſide, how far ſoever the Liquor wets the Stick, the figures will ſhew how many Gallons is in, and the complement thereof to the whole content is what it wants of being full.

Example.

Suppoſe I have a part, or a whole Barrel of Ale in a Beer-Barrel (for there are or ought to be no Ale-Barrels,

rels) and I would know how much is in or out: Put the Line for a Barrel downright in the Bung-hole to the oppoſite ſide, and then ſuppoſe it wets 13 *inches* 8 *tenths*, then there is 23 Gallons in and 13 empty.

But if you had put the Rule for a Kilderkin, and it had wetted as before, then there would have been but 15 gallons in, and 3 out, the complement of 15 to 18, for 15 and 3. makes 18.

But if you had uſed the Line for a But, there would have been about 52 Gallons in. Or of ſome roundiſh Buts, about 57 Gallons in, and 63 out, the Complement to 57. to 120 the whole content in a But.

The uſe of the Rule for Corn, and for Sea-Cole meaſures.

Take the Rule with the beginning end from you, and take the Diameter of the meaſure whatſoever it be, and the figures on the Rule right againſt the Inches Diameter ſhall expreſs how many Inches and hundred parts that meaſure ought to be in depth to make a true meaſure.

Two Examples of every meaſure.

A pint meaſure 2 Inches and ½ Diameter, ought to be 6 Inches 95 parts deep.

And at 2 Inches 3 quarters over 5. 75 deep.

A quart meaſure 3 Inches diam. ought to be 9 Inches and 63 parts deep.

And at 3 Inches 3 quarters Diam. 6-15 parts deep.

A Pottle-meaſure 4 inches Diameter, ought to be 10 Inches 82 parts deep.

And at 5 ½ Inches Diameter, 5.73 Inches deep.

A Gallon or half Peck 6½ broad, ought to be 8-19 deep, at 9 Inch Broad 4-26 deep.

A Peck 13 Inches broad or Diameter, ought to be 6-94 deep, and at 12 Inches broad 4-82 deep.

A half Buſhell 13 Inches broad muſt be 8-23. but at 16 Inches broad but 5-42. deep.

A

A Corn-Buſhell of 17 Inches broad, ought to be 9-62 deep, but of 21 Inches broad 6-29. But for Sea-cole meaſures take the next number forwards toward the beginning, as ſuppoſe a Cole-buſhell be 18 $\frac{1}{2}$ broad on the inſide, the Rule ſaith it ought to be 8-12, but you may take 8-33 the number next toward the begining *viz.* 8-33 becauſe a Corn-Buſhel ought to hold a quart more then a Corn Buſhel of water; and the Diameter from out-ſide to out-ſide ought to be 19 Inches and $\frac{1}{2}$, the half buſhel 14-$\frac{1}{2}$, the Peck 11$\frac{1}{2}$, the half Peck 9$\frac{1}{2}$ to make the heap to bear a proportion to the fats.

An Inſtrumental way to find the emptineſs of any Veſſel, by the Line of Numbers, Cloſe-Cask.

Extend the Compaſſes from the whole Diameter at the Bung to the next 1. the ſame extent ſhall reach the ſame way from the Inches and parts of emptineſs to a fourth number on a Line of Artificial Segments joyned to the Line of Numbers, which fourth number keep. Then as 1, the whole content in Gallons, So is the fourth number kept, to the emptineſs in the ſame Gallons the content was.

Example.

For a Beer-Barrel at 5 Inches dry, or 17 $\frac{1}{2}$ wet, or 5 empty, and 17$\frac{1}{2}$ full.

The extent from 22. 5 to 1 ſhall reach from 5 to 16. 4 on the Segments, or from 17. 5 to 83. 6.

Then the extent from 1 to 36. ſhall reach the ſame way from 16-4 to 5-9 for ſo much out, and from 83-6 to 30-1 for ſo much in, which two Sums put together makes 36 Gallons.

You may if you will ſay, As 1 to the mean Diameter, ſo is the mean emptineſs, *&c.* and the work will be ſomewhat more exact, but this is neer the matter, and eaſie.

Theſe Collections of Gaging, Courteous Reader, are the Iſſues of ſeveral years practice of ſeveral men, as Mr. Oughtred, *Mr.* Gunter, *Mr.* Renolds, *Mr.* Collins, *and many helps and Additions of my own; and if my brevity and inſufficiency wrong them not, they may be welcome to many a Learner, however very convenient for the further uſe of the Line of Numbers; and ſo I leave it as the moſt general Gaging that at preſent is extant.*

One example more by Mr. Oughtred's *way. Suppoſe a great veſſel whoſe length is* 70. 50 *Inches, and the Diameter at the bung* 2 *gallons* 03 *hundred parts, (for ſo they are properly called) and the Diameter at the head* 1 *gallon* 10 *parts, what is the content?*

Set the two Diameters down, that at the bung twice, and that at the head once, and add them together thus, And then ſay D as 1 to 5. 16, ſo is 70. 50, L 70. 50 to 363. 78. the content ſought for; that is 363 gallons 6 pints and a quarter, which 78 ſo to reduce do thus ſay on the line, As 100 to 80, ſo 78 to 6. 25, which is 6 pints and a quarter, the fraction ſought.

2|03
2|03
1|10
5|16

What is ſaid here of Reduction is general in any other, as from 12 to 10, either ſhillings or Inches to tenths of a ſhilling, or tenths of a Foot, or Pence or Farthings, Ounces, or Chauldrons, hundreds, either weight or Tale, and the rule is thus:

If 100 is 12 *d.* what ſhall 75 be? *facit* 9 Pencen or 9 Inches.

If 100 be 112 *l.* what ſhall 50 be? *facit* 56 pound.

If 100 be 8 pints, what ſhall 25 be? *facit* 2 pints.

If 100 be 48 *ſ.* what ſhall 30 be?

facit 14. 4, that is, 3*d*. 2 *f*. ½ *neer.*

If 100 be 36 Buſhels, what ſhall 24 be? *facit* 8 Buſhels ½ and better.

If 100 be 60 min. what ſhall 50 be? *facit* 30 minutes, or half an hour.

If 100 be 120, what ſhall 80 be? *facit* 96, of 112 of nails.

The like is for any kind of Reduction.

CHAP. VIII.

The uſe of the line of numbers in Queſtions that concern Military Orders.

PROB. 1.

Any Number of Souldiers being propounded, to order them into a Square Battle of Men.

Find by the 12 Problem of the ſecond Chapter, the Square root of the number given; for ſo much as that root ſhall be, ſo many Souldiers ought you to place in Ranck, and ſo many likewiſe in File, to make a Square Battle of men.

Example.

Let it be required to order 625. Souldiers, into a Square Battle of men; the Square rooot of that number is 25; wherefore you are to place 25 in rank, and as many in File, for fractions in this practice are not conſiderable. For had there been but 3 leſs, there would have been but 24 in ranck and file.

PROB. 2.

Any Number of Souldiers being propounded, to order them into a double Battle of men: that is, which may have twice as many in ranck as file.

Find out the ſquare root of half the number given, for that root is the number of men to be placed in file, & twice as many to be placed in ranck, to make up a double Battle of men.

Example.

Let 1368 Souldiers, be propounded tobe put in that order: I find by the 12 aforeſaid, that 26, *&c.* is the ſquare root of 684, (half the number propounded,)and therefore conclude, that 52 ought to be in ranck,& 26 in file, to order ſo many Souldiers into a double Battle of men.

PROB. 3.

Any number of Souldiers being propounded, to order them into a quadruple batail of men; that is, four times ſo many in Ranck as File.

Here the Square root of the fourth part of the number propounded, will ſhew the number to be placed in File, nd,four times ſo many are to be placed in Ranck.

So 2048 being divided by 4, the quotient is 512, whoſe root is 22 (6) nd ſo many are to be placed in File nd 88 in Ranck, being four times 22, *&c.*

PROB. 4.

Any number of Souldiers being given, together with their diſtances in Rank and File, to order them into a Square battail of ground.

Extend the Compaſſes from the diſtance in File to the diſtance in ranck; this done, that extent applyed the ſame way from the number of Souldiers propounded, will cauſe the moveable point to fall upon a fourth number, whoſe Square root is the number of men to be placed in File; by which, if you divide the whole number of Soldiers, the quotient will ſhew the number of men to be placed in Ranck.

Example.

2500 men are propounded to be ordered in a Square battle of ground, i ſuch ſort that their diſtance in Fil being ſeven Foot, and their diſtance i Ranck three Foot, the ground whereupon they ſtand may be a juſt ſquare to reſolve this queſtion, extend th Compaſſes upon the line of numbe downward from 7 to 3, (then because the fourth number to be found will in all likelyhood conſiſt of 4 figures,) if you apply that extent th ſame way, from 2500, in the ſeco

pa

part among the ſmalleſt diviſions, the moveable point will fall upon the fourth number you look for, whoſe ſquare root is the number of men to be placed in file. By which ſquare root if you divide the whole number of Souldiers, you have the number of men to be placed in ranck.

As 7 to 3, ſo 2500 to 1072, whoſe biggeſt ſquare root is 32, then as 32 is to 1, ſo is 2500, to 78.

PROB. 5.

Any number of Souldiers being propounded to order them in rank and file, according to the reaſon of any two numbers given.

This Problem is like the former, for as the proportional number given for the file, is to that given for the ranck, ſo is the number of Souldiers to a fourth number, whoſe ſquare root is the number of men to be placed in ranck, by which if you divide the whole, you may have the number to be placed in file.

Example.

Example.

So if 2500 Souldiers were to be martialled in ſuch order, that the number of men to be placed in file, might bear ſuch proportion to the number of men to be placed in ranck, as 5 bears to 12, I ſay then, as 5 is to 12, ſo is 2500 to 6000; whoſe ſquare root is 77 the number in rank: then as 77, is to 1, ſo is 2500 to 32, *&c.* The number of men to be placed in file.

CHAP. IX.

The uſe of the Line in Queſtions of Intereſt and Annuities.

PROB. I.

A ſum of money put out to Uſe, and the Intereſt forborn for a certain time, to know what it comes to at the end of that time, counting Intereſt upon Intereſt at any rate propounded.

Take the diſtance with your Compaſſes between 100, and the Increaſe of 100 *l.* for one Year, (which you muſt do very exactly) and repeat it ſo many times from the principal as it is forborn years, and the point of the Compaſſes will ſtay on the Principal with the Intereſt, and increaſe according to the rate propounded.

Example.

I deſire to know how much 125*l.* being forborn 6 year will be increaſed, according to the rate of *6 l. per cent.* reckoning Intereſt upon Intereſt or Compound-Intereſt.

Extend the Compaſſes from 100 to 106; that extent being 6 times repeated from 125, ſhall reach to 177*l.* the principal increaſed with the intereſt at the term of 6 years, at the rate propounded.

But if it were required for any number of Months, then firſt find what 100 is at one Month, then ſay thus, If 100 give 10 *s.* at one month, what ſhall 125 be at 6 months end? *facit* 75 *s.* And the work is thus:

Firſt ſay, If 100 give 10 *s.* at one months end, What ſhall 125? and it makes 12*s.* 6*d.* then ſay, If one month require 12*s.* 6*d.* What ſhall ſix months require? *facit* 75 *s.* that is three pound fifteen ſhillings, the thing required to be found.

PROB. 2.

A ſum of money being due at any time to come, to find what it is worth in ready money.

This queſtion is only the inverſe of the other; for if you take the ſpace between 106 and 100, and turn it back from the ſum propoſed, as many times as there are years in the queſtion, it ſhall fall on the ſum required.

Example.

Take the diſtance between 106 and 100, and repeat it 6 times from 177, and it will at laſt fall on 125, the ſum ſought.

PROB. 3.

A yearly Rent, Penſion, or Annuity being forborn for a certain term of years, to find what the Arrears come to at any rate propounded.

Firſt you muſt find the principal that ſhall anſwer to that Annuity, then find to what ſum the Principal would be augmented at the rate and term of years propounded; then if you ſubſtract the principal out of that ſum, the remainder is the Arrears required.

Example.

A Rent, or Annuity, or Penſion of 10 pound the year, forborn for 15 years, What will the arrears thereof come to at the rate of 6 *per cent*. compound intereſt?

The way firſt to find the principal that doth anſwer to 10 *l.* is thus: If 6 pound hath a 100 for his principal, What ſhall 10 have? *facit* 166*l.* 16*s.* or 166 *l.* 8 *s.* for the extent from 6 to 10 will reach from 100 to 166-8. which is 166 *l.* 16*s.* Then by the firſt *Problem* of this Chapter, 166 *l.* 16 *s.* forborn 15 year, will come to 398 *l.* then ſubſtract 166 *l.* 16 *s.* out of 398 pound, and the remainder, *viz.* 231 pound 4 ſhillings is the ſum of the arrears required. But note, in working this queſtion, your often turning, unleſs your firſt extent be moſt preciſely exact, you may commit a groſs error, to avoid which, divide your number of turns into 2, 3, or 4 parts, and when you have turned over one part, as here 5, for three times 5 is 15, open the Compaſſes from thence to the principal, and then turn the other two turns, *viz.* 10--15. and this may avoid much errour, or at the leaſt much mitigate it; for in theſe queſtions the larger the Line is, the better.

PROB. 4.

A yearly Rent or Annuity being propounded, to find the worth in ready money.

Firſt, find by the laſt what the arrears come to at the term propounded, and then what thoſe arrears are worth in ready money, and that ſhall be the value of it in ready money.

Example.

What may a Leaſe of 10*l. per ann.* having 15 year to come be worth in ready money? I find by the laſt *Problem* that the arrears of 10 *l. per ann.*

forborn 15 years, is worth 231*l.* 14*s.* And likewiſe I find by the ſecond *Problem* that 231 *l.* 4 *s.* is worth in ready money 96 *l.* 15 *s.* and ſo much may a man give for a Leaſe of 10 *l.* *per ann.* for fifteen years to come, at the rate of 6 *l. per cent.*

But if it were not to begin preſently, but to ſtay a certain term longer, then you muſt adde that time to the time of forbearance; as ſuppoſe that after 5 years it were to begin, then you muſt ſay, 231 *l.* 4 *s.* forborn 20 years is worth in ready money, and it is 72 pound 8 ſhillings; and that ſhall be the value of the Leaſe required.

PROB. 5.

A ſum of money being propounded, to find what Annuity to continue any number of years, at any rate propounded, that ſum of money will purchaſe.

Take any known annuity, and find the value of it in ready money; this being done, the proportion will be thus: As the value found out is to the annuity taken, ſo is the ſumme propounded to the annuity required.

Example.

What annuity to continue fifteen years will 800 *l.* purchaſe, after the rate of *6 l. per cent.* Here firſt I take 10 *l. per ann.* for fifteen year, and find it to be worth in ready money *96 l.* *16 s.* by the laſt *Problem*; then I ſay, as *96 l.* 8 *s.* is to 10, ſo is 800 to 82--7, which is 82 *l.* 14 *s.* and ſo much neer do I conclude will an annuity of 82 *l.* 14 *s. per ann.* be worth for fifteen years, after the rate of *6 l. per cent.* *viz.* 800 *l.*

CHAP. X.

The application of the Line of Numbers to uſe in domeſtick affairs, as in Coals, Cheeſe, Butter, and the like.

I have added this Chapter, not for that I think it abſolutely neceſſary, but only becauſe I would have the abſolute applicableneſs of the Rule to any thing, be hinted at; for it may be the anſwer of ſome, Do you come with a Rule to meaſure my commodities which are ſold by weight? Yea ſo far as there is proportion, it concerns that, and any thing elſe, the Application of which I leave to the induſtrious practitioner: only I here give a hint. As much as to ſay, here is a treaſure if you dig you may find, for ſome may be apt to think it being a *Carpenter's Rule*, it is fit but for *Carpenters* uſe only: but know, that in all meaſures which are either lengths, Superficials or Solids, or as ſome call them Longametry, Planametry, and Solidametry: and in all liquids, by weight or meaſure, and in all time, either by Years, Months, Weeks, Days, Hours, Minutes, and Seconds, and almoſt (I think I may ſay,) in all things number is uſed, and in many things proportional numbers, why then may not this line put in for a ſhare of uſe, ſeeing it is wholly compoſed of, and fitted for propor-tional numbers, and of ſo eaſie an attainment, for any ordinary Capacity, and chiefly intended for them that be ignorant of Atithmetique, and have not time to learn that noble ſcience as ſome have ?

And firſt for more conveniency of Reduction, take theſe Rules of Reduction:

Rules for Engliſh money.

Note, that 4 farthings make a penny; 16 farthings, 8 half pence, or 4 pence, make a groat, 48 farthings, 24 half-pence, or 12 pence, make a ſhilling: 40 pence or 10 groats, is 3 ſhillings 4 pence; 80 pence, 20 groats, or 6 ſhillings 8 pence is a noble; 160 pence, 40 groats, or 13 ſhillings 4 pence is a mark; 20 ſhillings, 4 crowns, 3 nobles, or 2 angels, is a pound ſterling.

Rules for Troy-weight.

Note that 24 grains is a penny weight: 20 penny weights, or 24 carrots,

rots, is an ounce Troy : 12 Ounces is a pound : 25 *lib.* a quarter of a hundred, 50 *lib.* half a hundred : 75 *lib.* 3 quarters of a hundred, and 100 *lib.* is an hundred weight Troy.

Rules for Aver-du-pois weight.

Note that 20 grains, make a ſcruple: 3 ſcruples , is a dram : 8 drams , is an ounce : 16 ounces, is a pound, 8 pound, a ſtone : 28 *lib.* a quarter of an hundred ; 56 *lib.* half a C. 84 *lib.* 3 quarters of an C. and 112 *lib.* or 14 Stone, or 4 quarters of a C, is an hundred weight : 5 C, is a Hogſhead weight : 19½ C, is a Fother of Lead : and 20 C, is a Tun weight, and note that *l.* ſignifies a Pound in money : and *lib.* ſignifies a Pound in weight, either Troy, or Averdupois.

Rules for Concave Dry-meaſure.

Note that 2 pints is a quart 2 quarts a pottle, or a quarter of a peck : 8 pints 4 quarts , 2 pottles is one Gallon, or half a peck, 2 Gallons is a peck : 2 pecks make half a Buſhel : 4 pecks, or 56 *lib.* make a Bu-

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ſhel: 2 Buſhels, is a Strike: 2 Strikes a Coomb, or half quarter; 2 Coombs 4 Strikes, or 8 Buſhels make a quarter, or a Seame: 10 quarters, or 80 Buſhels make a Laſt.

Rules for Concave Wet-meaſure.

Note, that 2 pints is a quart: 2 quarts a pottle; 2 pottles 4 quarts, or 8 pints make a Gallon: 9 Gallons make a Firkin, or half a Kilderkin: 18 Gallons make 2 Firkins, a Kilderkin, or a Rundlet; 36 Gallons is 2 Kilderkins, or a Barrel; 42 Gallons make a Terce, 63 Gallons or 3½ Rundlets make a Hogſhead, 84 Gallons, or 2 Terces, make a Tercion, or Punchion: 126 Gallons, is 3 Terces, two Hogſheads, one Pipe, or But. A Tun is 252 Gallons 14 Rundlets, 7 Barrels, 6 Terces, 4 Hogſheads, 3 Punchions, 2 Pipes, or Buts. Note that in ſweet Oyl 236 Gallons make a Tun, but of Whale Oyl 252 goes to the Tun.

Water-meaſure.

Note that 5 Pecks is a Buſhel, 3

Buſhels a Sack, 4½ Buſhels a Flat; 12 Sacks, 4 Flats, or 36 Buſhels, make a Chaldron of Coals.

Rules for Long-meaſure.

Note that 3 Barley corns make an Inch: 2¼ Inches make a Nail: 4 Nails or 9 Inches make a quarter of a Yard, 12 Inches make a Foot: 3 Foot, 4. Quarters, 16 Nails, or 36 Inches, make a yard, 45 inches or 5 quarters of a yard make an ell, 5 foot is a pace, 6 feet, or 2 yards is a fathom, 5½ yards, or 16½ feet, is a pole, rod, or perch, 160 perch in length, and one in breadth, or 80 perch in length, and 2 in breadth, or 4 in breadth, and 40 in length, make an acre.

220 yards, or 40 pole, is a furlong: 1760 yards, 320 pole, or 8 furlongs, is an Engliſh mile; 3 miles is a League, 20 leagues or 60 mile is a degree, in ordinary account, and every mile a minute.

Rules for Motion and Time in Aſtronomy and Navigation.

Note that a minute contains 60 ſeconds, and 60 minutes is one degree: and 30 degrees is one ſign; 2 ſigns, or 60 degrees is a ſextile ✱. 3 ſigns, or 90 degrees is a quadrant, or quartile □: 4 ſigns, or 120 degrees, a trine △: 6 ſigns, or 180 degrees is one oppoſition ☍ or ſemicircle, 12 Signs or 360 deg. is a Conjunction ☌: and the Suns Annual, or Moons monthly motion. Note alſo, every hour of time hath in motion 15 Degrees. And a minute of time, hath 15 minutes of motion, and one Degree of motion, is 4 minutes of time.

Note further, that every hour of time, hath 60 minutes, therefore 45 is 3 quarters, 30 is half, 15 is a quarter of an hour; 24 hours a day natural; 7 days a week; 365 days and about 6 hours is a year. Hence it follows, that $\frac{1}{4}$ of a degree in the heavens, is 5 Leagues on the earth, or 15 minutes of motion above, is 1 minute of time below, therefore a degree,

gree, or 60 minutes of motion, is 4 minutes of time, as before is ſaid.

All theſe rules, I ſhall expreſs more largely, and in ſhorter terms, by theſe following Tables.

Equation for Motion.

	Signs.	*Degr.*	*Minutes.*	*Seconds.*
Notethat the 12 Signes is	12	360	21600	1296000
One Signe is	1	30	1800	108000
One Degr. is		1	60	3600
One Min. is			1	60

Equation for Time.

	Mon.	*Week.*	*Day.*	*Hour.*	*Minute.*
One *Year*	13	52	365	8760	52560
Month hath	1	4	28	671	40320
Week hath		1	7	168	10080
Day natural			1	24	1440
Hour hath				1	60
Minute is					1

Equation

Equation for Long-meaſure.

	Mile.	Furl.	Perch.	Yards.	Feet.	Inches.
Leag.	3	24	960	5971¼	15840	190080
Mi.	1	8	340	1760	5280	63360
Furlong		1	40	220	660	7920
Per. Rod. Pol.			1	5½	16½	198
Acre contains of *Squar. Perc.*			160	14520	43560	
Acre is in leng.		1	40	220	660	7020
Acre is in bredth			4	22	66	792
1 *Rood*, or ¼ *of an acre is in* len.			40			
1 *Rood*, or ¼ *of an acre is in* bread.			1	5⅕	16½	198
One Fadom is					6	72
One Elne Engliſh is					3¾	45
One Yard is					3	36
One Foot is					1	12
One Inch is 1 *Inch 3 grains.*						1

Equation of Liquid-meaſure.

	Gallons.	Pottle.	Quart.	Pints.
Tun of ſweet Oyl	236	472	944	1888
Tun of Wine is	252	504	1008	2016
But or Pipe is	126	252	504	1008
Tertian of wine is	84	168	336	672
Hogſhead is	63	126	252	504
A Barrel of Beer, or 2 runlets of wi. is	36	72	144	288
Kilderkin or one Runlet is	18	36	72	144
Barrel of Ale is	32	64	128	256
Kilderkin of Ale	16	32	64	128
Firkin of Beer is	9	18	36	72
Firkin of Ale is	8	16	32	64

Equation

Equation of ſmall dry meaſure, and then of great meaſure.

	Peck.	Gal.	Pottl.	Qu.	Pi.
Buſhel of water-m. is	5	10	20	40	80
Buſhel of land-me. is	4	8	16	32	64.
One Peck is	1	2	4	8	16
One Gallon is		1	2	4	8
One Pottle is			1	2	4
One Quart is				1	2

	Laſt.	Weig.	Chal	Qu.	Buſh.	Peck.	Pints.
Laſt of Dry-m. is	1	2	2½	10	80	320	5120
One Weight is		1	1¼	5	40	160	2560
Chaldron of coals			1	4	36	144	2098
Quarter of wheat is				1	8	32	512
One Buſhel is					1	4	62

Equation for Avoirdupois weight.

	Hogſheads.	C.	*Stons.*	*Lib.*	*Ounces.*	*Drams.*	*Scruples.*	*Grains.*
Tun W. *groſs is*	4	20	280	2240	35840	286720	860160	17203200
One Hogſhead is	1	5	70	560	8900	71680	215040	4300800
One C. *or Hund. is*		1	14	112	1792	14336	43008	860160
One Half C. *is*			7	56	876	7168	21504	430080
One Quarter of C. *is*			3½	28	448	4584	10752	213040
One Stone is			1	8	128	1024	3072	61440
One Lib. Pound is				1	16	128	384	7680
One Ounce is					1	8	24	480
One Dram is						1	3	60
One Scruple is							1	20

Equation for Troy-weight.

	Lib.	*Ounce.*	*Dp.*	*Carrots.*	*Grains.*
C.*w.*	100	1200	24000	28800	576000
$\frac{1}{2}$C. *is*	50	600	12000	14400	288000
$\frac{1}{4}$C. *is*	25	300	6000	7200	144000
$\frac{1}{8}$C. *is*	12$\frac{1}{2}$	150	3000	3600	72000
Pound	1	12	340	288	5760
Ounce		1	20	24	480
One Penny weight is			1	1$\frac{1}{5}$	24
One Carrot Troy is				1	20
One Grain is					1

Equation of Money.

	Mark	*An.*	*Nob.*	*Cro.*	*Sh.*	*Groat.*	*Penc.*	*Far.*
Pound ſt.	1$\frac{1}{2}$	2	3	4	20	60	240	960
Mark is	1	1$\frac{1}{3}$	2	2$\frac{2}{3}$	13$\frac{1}{3}$	40	160	640
An Angel is		1	1$\frac{1}{2}$	2	10	30	120	410
A Noble is			1	1$\frac{1}{3}$	6$\frac{2}{3}$	20	80	320
A Crown is				1	5	15	60	240
A Shilling is					1	3	12	48
A Groat is						1	4	16
A Penny is							1	4

The uſe of which, (to come to our intended purpoſe,) may be thus. There you ſee how many farthings, pence, groats, ſhillings, and the like is in one, or any uſual piece of coyne, alſo how many ounces, ſcruples, in any kind of weight; and the like for meaſure, both liquid and dry; and alſo in time: now if you would know how many there ſhall be, in any greater number then one: then ſay by the Rule (or line of numbers) thus, If 48 Farthings, be one ſhilling, how many ſhillings is 144 Farthings, *facit* 3 ſhillings, for the extent from 48, to 1, will reach from 144, to 3. and the contrary. Again, if a mark and a half be one pound, how many pounds is 12 mark? the extent from 1-50, to 1 ſhall reach from 12, to 8. for reaſon muſt help you not to call it 80 pound: again if 3 nobles be one pound, what is 312 nobles? *facit* 104 pound, the extent from 3 to 1, will reach from 312 to 104.

Further, If a Chaldron of coals coſt 36 ſhillings, what ſhall $\frac{1}{2}$ a Chaldron coſt? *facit* 18. (but more to the matter) if 36 Buſhel coſt 30 *ſh.* what ſhall 5 Buſhels coſt? *facit* 4. 16. that is by reduction 4*s.* 2*d.* neer the matter, or penny, 3 farthings, $\frac{1}{2}$ farthing, and better: or on the contrary; If one Buſhel coſt 8 pence, then what coſt 36? *facit* 288 pence; which being brought to ſhillings is juſt 24. which you may do thus: If 12 pence be one ſhilling, how many ſhall 288 be? *facit* 24. for the extent from 12 to 1, ſhall reach the ſame way from 288 to 24. as before: the like may be applyed to all the reſt of the rules of weight, and meaſure; of which take in fine, ſome examples in ſhort, and their anſwers.

If 14 Stone be one C. what is 91 Stone? *facit* 6 $\frac{1}{2}$ C.

If one Ounce be 8 Drams, how many Drams in 9 Ounces, *facit* 72, the Extent from 1 to 8 reacheth from 9 to 72.

If one Buſhel of water meaſure be 5 Pecks, how many Pecks is 16 Buſhels? *facit* 80 Pecks.

If one Barrel hold 288 pints, how much will a Firkin hold? this being the fourth part of a Barrel, work thus, if 1 give 288 what 25? *facit* 72, the anſwer ſought.

If one week be 7 days, how many days is 39 weeks? as 1 is to 7, ſo is 39 to 273. So many days in 39 weeks.

If 160 perch be one acre, how many acre is 395 perch? *facit* 2.492 that is neer $2\frac{1}{2}$ acres.

If 8 Furlongs make one mile, how much is 60 Furlongs? *facit* $7\frac{1}{2}$ mile: for the extent from 1 to 8, gives from 60 to 7.50.

CHAP. XI.

To meaſure any Superficies, or Solid by Inches only, (or by Foot-meaſure) without the help of the line, by Multiplication of the two ſides.

PROB. 1.

PROB. 1.

Poſſibly that this little Book may meet with ſome that are well skilled in Arithmetick, and being much uſed to that way, are loth to be weaned from that way, being ſo artificial and exact, yet though they can multiply & divide very well, yet perhaps they know not this way, to ſave their diviſion and yet to take in all the fractions together as if of one denomination: I ſhall begin firſt with Foot-meaſure being the more eaſie, and I ſuppoſe my Two-foot-rule to be divided into 200 parts, and figured with 10. 20. 30. 40. 50. 60. 70. 80. 90. 100. And then ſo again to 200. as in the 3 Chap. and then the work is only thus: ſet down the meaſure of one ſide of the ſquare, or oblong thus, as for example, 7.25, and 9.88, and multiply them as if they were whole numbers, and from the product cut off 4 figures, and you have the content in Feet, and 1000 parts of a Foot, or Yard, Ell, Perch, or whatſoever elſe it be. Note the examples following.

```
     7 25            12 29
     9 88            19 72
   ------           ------
    58 00            24 58
   580 0            860 3
  6525            11061
 --------          1229
  71|6300        ---------
  -------         242|3588
                   ------
```

For any kind of flat Superficies, this is ſufficient inſtruction to him that hath read the firſt part; but if it be Timber, or Stone, you muſt thus find the Baſe, and then another work will give you the other ſide, as in Chapter 5 Problem 2. or, Multiply the length by the **Product** of the breadth and thickneſs, and that Product ſhall be the content required.

PROB. 2.

To Multiply Feet, Inches, and 8 parts of an Inch together without Reduction, and ſo to meaſure Superficial (and Solid) meaſure, Firſt, Multiply all the whole Feet, then all the Feet and Inches, acroſs, and right on, then the parts by the Feet, and alſo the Inches, and parts, acroſs and right on; then add them together, and you ſhall have the anſwer in feet, long Inches,(that is,in pieces of a Foot long, and an Inch broad) ſquare Inches,and 8 parts of a Square Inch : as for example.

Let a peice of Board be given to be meaſured that is 3. 3. 5. *i. e.* three Foot, three Inches, and 5 eights, one way, and 2. 3. 4, the other way. I ſet the numbers down in this Manner, & then right on, firſt as the line in the Scheme from 2 to 3 leads.

3.3.5.
2.3.4.

I ſay thus, 3 times 2 is *6*, ſet *6* right under 2. and 3 as in the example, in the left page : for *6* Foot, as is clear, if you conſider the Scheme over the example, *viz.* the ſquares noted with *f.* then for the next I ſay croſs-wiſe, 2 times 3 is *6*, *viz.* long Inches, as you may perceive, by the 2 long ſquares marked with *9* L. and *6* L.

which 6 I put in the next place to the right hand, as in the example; then for the next, *viz.* 3 times 3. is 9, (croſwiſe, as the ſtroke from 3 to 3 ſhews) which 9 is alſo 9 long Inches, as the Scheme ſheweth, and muſt be put under 6, in the ſecond place toward the right hand, in the Scheme it is expreſs'd by the 3 long Squares, marked with L9. Then laſtly for the Inches, 3 times 3 is 9, going right up, as the ſtroke from the 2 threes lead you: but note, this 9 muſt be ſet in the next place to the right hand, becauſe they are but 9 Square Inches, but had the Product been above 12, you muſt have Subſtracted the 12 *s.* out, and ſet them in the long Inches place, and the remainder, where this 9 now ſtandeth, and this 9 is expreſs'd in the Scheme, by the little Square in the corner markt with (□ 9.)

Then now for the Fractions, or 8 parts of an Inch, firſt ſay, croſwiſe as the longeſt prick line doth lead you to; 3 times 4 is 12, for which 12, you muſt ſet down 1. 6, that is 1 long Inch, and 6 Square Inches, the reaſon is, a piece 8 half quarters of an Inch broad, and 12 Inches long, is a long Inch, or the twelfth part of a Foot ſuperficial, and if 8 be 12 Square Inches, then 4 muſt needs be 6 Square Inches: therefore, in ſtead of 12, I ſet down 1. 6, as you may ſee in the example, and in the leaſt long Square of the Diagram, or Scheme. Then do likewiſe for the other long Square, which is alſo multiplyed acroſs; as, two times 5 is 10. that is, as I ſaid before, 1. 3, as the Example and Scheme make manifeſt, conſidering what I laſt ſaid, and it is marked by the 2. 00. But if this or the other had come to a greater number, you muſt have Subſtracted 8s. as oft as you could, and ſet down the remainder in the place of Square Inches, and the number of 8s. in the place of Long Inches, as here you ſee.

Then for the two ſhorter Long

Squares next the corner, ſay croſwiſe again, Three times 5 is 15, that is 1, 7, becauſe eight Half-quarters an Inch long do make one ſquare Inch, as well as eight Half-quarters a Foot long made one Long Inch: Therefore I ſet 1 in the place of ſquare Inches, and 7 in the next place to the right hand, and it is expreſſed in the Diagram by the ſmall long ſquare, and marked with * 1. 7.

Then again for the other little long ſquare, ſay croſwiſe, as the ſhorter prick line leads you, Three times 4 is 12, that is 1. 4; and do by this as the laſt: It is noted in the Scheme by 1-4.

Then laſtly for 5 times 4, as the ſhort prick line ſheweth you, is 20: out of which 20 take the 8 *ſ.* and ſet them down in the laſt place, and the 4 remaining you may either neglect, (or ſet it down a place further) for you cannot ſee it on the Rule; therefore, I thus adviſe, if it be under 4. neglect it quite, but if above, increaſe the next a figure more if 4 then it is a half, and ſo may be added; for note, 64 of theſe parts make but one ſquare Inch; of which parts, the little ſquare in the right hand lower corner of the Scheme is 20, for which I ſet down 2. 4, that is two Half-quarters, and 4 of 64. which is the laſt work, as you may ſee by the Scheme and Example.

Now to add them together ſay thus, 4 is 4, which I put furtheſt to the right hand, as it were uſeleſs, becauſe not to be expreſt; then 4 7 2 are 13, from which take 8, and for it carry 1 on to the next place, or as many times 1 as you find 8, and ſet down the remainder, which here is 5, then 1 I carried, and 13619, is 21, from which I take 12, and ſet down 9, becauſe 12 ſquare Inches, is one long Inch: then 1 I carried, (or more, had there been more 12 *s*.) and 1169 is 18, from which take 12, as before, there remains 6, that is, 6 long Inches, and ſo had there been more 12 *s*. ſo many you muſt carry to the next place, becauſe 12 long Inches is one Foot, laſtly 1 I carried, and 6 is 7 Foot, ſo that the work ſtands thus,

F. La. In. Sq. In. 8 -64
7·—6—9—5—4

and ſo for any other meaſure Superficial or Solid.

An Appendix.

CHAP. I.

The Deſcription and uſe of a general and particular Sun-dial made for the Latitude of 51. 30. *North or the like for any other Latitude.*

1. Firſt, the Dial it ſelf is in form of a Quadrant, Sextance, or Circle, according as you pleaſe.

2. There is a ſtring fitted, to hang

the Horizontal line of the Dial, Horizontally or parallel to the horizon.

3. There is the Centre, hole, wherein to ſtick a pin, ſtraw, bent, or hair, to give a ſhadow.

Secondly, for the lines delineated on the Dial, the firſt I ſhall take notice of is the Horizontal line, and it is a long ſtreight line drawn perpendicular to the ſtring, and cuts the Center juſt in the middeſt.

2. You have next the Verge or Limb, (be it Quadrant, Sextance, or Circle) the *90* Degrees of a quadrant, or but *60* of *90* if it be but a Sextance or of a round form, being ſufficient for this Latitude: and the figures on that line is 10. 20. 30. 40. 50. *60*. 70. 80. *90*.

3. Next to that (toward the Center, and concentrick or parallel to the former Circle of degrees) you have a line of quadrat, or ſhadows, or if it be large you may have both quadrat, and ſhadows, and the figures, on the quadrat, or 10. 20. 30. 40. 50. and then

back again to 1. 10, or in large quadrants the 50 is called a 100, and 10. 20, and 20. 40, *&c.*

But the line of ſhadows, is figured with 12.11.10.9.8.7.6.5.4.3.2.1.in the middle againſt 50, and then 1. 2. 3. to 12. back again; the firſt part of which is called the right ſhadow: the other is called contrary ſhadows.

4. Next to that you have two more lines, (concentrick to the former in quadrants and Sextances; But in round Dials, they are but as it were concentrickal) on which are divided a Kalender of months and days, if they be large, but in thoſe of ordinary bigneſs, is but every fifth and tenth day expreſſed; and ſingle days are reaſonably underſtood, of which two Circles the uppermoſt contains that half year in which the days be increaſing, *viz.* from the 10. of *December* to the 10. or 11. of *June*; and the lowermoſt Circle contains the other half, decreaſing or ſhortning. And at the end of every month there is a long

ſtroke, being the laſt day of that month, and then by that, in the next moneth, you have the firſt letter (or more letters,) of the name of that month; ſo that all the letters in theſe two lines are: I. F. M. A. M. I. I. A. S. O. N. D. for *January*, *February*, &c.

5. Next to the Kalender, you have 25 concentrick Circles, if they are lines of declination, or but 19, if they be lines of the Suns-riſing, and every 5 of them if they be declinations, or every fourth if they be lines of riſing, is expreſs'd and diſtinguiſhed with pricks; for every 5 and tenth Degree of declination, or for every whole, and half hour of Suns riſing; as the figures ſet to them, at the end of them (next the horizontal line) ſhew, if they be of Suns riſing being 4.5.6. or the contrary end if they be linesof de-lination, noted with 10.20. will ſhew; the uppermoſt of which 25, or 19 lines, repreſents the *Æquinoctial*: and the loweſt the two *Tropiques* of *Cancer*, and *Capricorn*.

6.

6. Thoſe lines which deſcend downwards ſloping from the *Æqui-noctial* (or uppermoſt concentrick Circle,) to the *Tropique* (or lowermoſt Circular line,) towards the right hand, are the Summer hour lines; and are 9 in number , when they are only whole hours. But in large Dials there may be put halfs, and quarters, and then there are 8 prick'd hour lines, for 12 being the laſt needs no pricks for diſtinction. And they are figured above the *Æquinoctial* with 6.7.8.9.10.11.12, and under the *Tropiques* with 8. 7. 6.5.4.3.2.1.12. for the ſame line hath two figures, *viz.* 4 & 8, 7 & 5, 6 & 6, 5 & 7, 4 & 8, 3 & 9, 2 & 10, 1 & 11, 12 & 12. That is, the ſame line that is for 4 in the morning, is for 8 at night, and the like is both for winter and ſummer ; the reaſon is , look how high the Sun is at 7 in the morning, ſo high is it at 5 in the afternoon, and the like.

7. Thoſe lines that deſcend from the *Æquinoctial* toward the left hand

are the winter hours, and are figured above as before, but below with 12. 1.2.3, for in the ſhorteſt days, the Sun ſets before 4, and in large Dials, there are halfs, and quarters alſo, and diſtinguiſhed as before, but of whole hours at the *Tropiques* there is but 4, but at the *Æquinoctial* there be 6, and a point repreſenting the hour of 6.

8. And laſtly, in the ſpare room beyond the *Æquinoctial*, you have ſet a perpetual Almanack, whereby, if you know the day of the month, you may find the day of the week, and the contrary.

Alſo in ſome Almanacks, you have the Dominical letter, Leap-year, and Epact, to find the Moons-age, the largeſt and uppermoſt of which ranks of figures, are the 12 months, the next 5 are the 31 days of the month, and the reſt, if any be, are according to their names: thus much for deſcription.

One thing more I think convenient to hint, to make it ſerve for all faſhions of Dials of this kind, and it is this; ſome Dials of this kind, have the Kalender of months and days on the backſide, in 1, 2, or 4 Circles and lines of the Suns declination, riſing, true place, and amplitude and the right aſcenſion; and the uſe is only thus. Lay a thred on the day of the month and the Centre, and it cuts or ſheweth all the other in their reſpective lines. It being ſo eaſie, and alſo not to our preſent purpoſe, I ſhall not give any example, but come to the uſes of the foreſide, which are ſufficient for the hour of the day, the thing promiſed.

Note alſo that by the addition of on line it is made to ſerve for all latitudes: alſo in the form of a very ſtrong and handſom Tobacco-box.

CHAP. II.

The uſe of the Dial.

PROB. 1.

PROB. 1.

How to hold the Dial in time of Obſervation.

Hang the ſtring of the Dial over your thumb, on your left hand, (or you may hold it between your thumb and the middle of your fore-finger) and ſtretch your 4 fingers ſtreight out, and let the Dial hang at liberty, juſt touching the palm of your hand, that it may be ſteady, then turn your whole body about, till the edge of the Dial (or your fingers ends) be juſt againſt the Sun: then ſhall you ſee the ſhadow of any thing ſtuck in the Centre, though never ſo ſhort, to reach quite through the Dial, and then it is held right.

PROB. 2.

To find the Suns Altitude.

Stick a pin (the ſmaller the better) in the Centre, and hold it up as before, and the ſhadow will ſhew on the limb the Suns Altitude required.

Example.

At 8 of the clock on the 11 of *June* in the morning, I wonld know the Suns Altitude; I hold it up as before, and I find it to be 36.46, that is 36 Degrees and 46 Minutes, each Degree being 60 Minutes, as in the Tables of Reduction.

PROB. 3.

To find the perpendicular height of any thing by its ſhadow, by the line of ſhadows.

Hold up the Dial by the thred as before, and look on what diviſion of the line ſhadows, the ſhadow of the pins cuts, that is the true height or length of the ſhadow, by which to get the height of any perpendicular thing, or the very top of any leaning thing, that cauſeth the ſhadow.

Example.

On the ſame 11 of *June* at neer 9 a Clock in the morning, I hold up my Dial, and I find the ſhadow to fall juſt on 1, on the line of ſhadows, or 45 on the Degrees, ~~therefore~~ I ſay, that the height of the object, that cauſeth the ſhadow, and the ſhadow are both of one length: but if it had fallen on 2, (that is to ſay, of right ſhadow) then the object is, but half the length of the ſhadow meaſuring upon a level ground, from the end of the ſhadow, to right under the object that cauſeth the ſhadow; if it falls on 3, the ſhadow is 3 times as long as the thing is, and ſo to 12, to 12 times longer, and the ſtrokes between note one tenth, 2 tenths, 3 tenths, *&c.* more; but if it falls beyond 1, on contrary ſhadow, then the ſhadow is ſhorter accordingly, as will appear very plain with a little practice.

Or rather thus by the Numbers.

Count the middle 1 on the Rule, as 1 at 45 on the Dial, then if the Sun be under 45, count them on the rule toward 10, and if above 45 the contrary; then as the parts cut are to the middle 1, ſo is the length of the ſhadow to the altitude required.

PROB. 4.

The Uſe of the Quadrat.

To uſe the Quadrat, you muſt have a hole in the other end of the horizontal line, and alſo ſome where in the Dial, ſquare (from the Centre) to the horizontal line; alſo you muſt have a thred and plummet, then the uſe is thus. Stick a pin in the Centre, and thereon hang the plummet, then put a pin in the other whole, that is perpendicular to the horizontal line, and juſt over the Centre; and hold up the Dial in your right hand, and make the ſtring to play evenly by the Superficies of the Dial, when you ſee the object right againſt both the pins; then obſerve what ſtroke is cut by the thred on the line of quadrat, (or ſhadows for that may be uſed ſo alſo,) for if you go backwards or forwards till you make the thred to fall on 1, in the ſhadows or on 50 in the quadrat, then is the height of the Houſe, Steeple, Tree, or the like, equal to the diſtance, between you and it, adding the height of your eye to it. But if it had fallen on 25 of the quadrat, or 2 on the ſhadows, then the diſtance had been twice as much as the height, (if right ſhadow) but for contrary ſhadow, the contrary. I ſhall ſay no more to this, only give you a caution, that if you look from the height of any place downwards, then you muſt put that pin next the Centre to your eye, and look downwards to your object, and then the ſide which before was right ſhadow, will become contrary ſhadow, and the contrary. Note one thing further, that if your inſtrument be a Sextance, or a Circle, and you cannot have all the quadrat, as on a quadrant: you may then move the pin to the hole at the other end of the horizontal line: and you ſhall ſee that defect to be ſupplyed. Note laſtly, that by heights, we ſpeak only of perpendicular or upright heights; and in diſtances, only of levels, or horizontals.

PROB. 5.

How to find unacceſſable heights by the quadrat at two Obſervations.

If the place which is to be meaſured cannot be approached unto, then

wor

work thus, to find both height and diſtance, firſt make choice of a place where looking up I find the thred to fall on 50 in the quadrat, then the diſtance will be equal to the height. Then make a mark at that Station, and go directly backward in a right line, with the former diſtance: and make choice of a ſecond Station, where the thred may fall on 25 parts of right ſhadow, then this ſecond Station is double to the height, and alſo to the diſtance, departed from the firſt Station: and the half therefore is the height, and firſt diſtance. But if it be ſo, you cannot come to take ſuch a height as 50 and 25, then take as you may, as ſuppoſe one be at 25, and the other at 20, and ſuppoſe the height to be 100. I find that, As 25 the parts cut, are to 50 the ſide of the quadrat, ſo is 100 the ſuppoſed height, unto 200 the diſtance. And as 20 the ſecond Station, to 50 the ſide of the quadrat; ſo is 100 the ſuppoſed height, unto 250 the ſecond diſtance;

wherefore the difference between the Stations ſhould ſeem to be 50, then if in meaſuring you find it to be either more or leſs, then this proportion doth hold as from the ſuppoſed difference, to the meaſured difference. ſo from the ſuppoſed height, to the true height, and from the ſuppoſed diſtance, to the true diſtance.

And now ſuppoſe the difference between the two Stations were found to be 30, by meaſuring, Then as 50 the ſuppoſed difference, to 30 the true difference, ſo is 100 the ſuppoſed height, to 60 the true height; And 200 the ſuppoſed diſtance to 120 the true; and 250 at the ſecond Station, unto 150 the diſtance; the like reaſon holdeth in all other examples of this kind, and if an Index with ſights were fitted to the Centre, it might ſerve for all other horizontal diſtances by the ſame reaſon.

PROB. 6.

Having the Day of the Week to find the Day of the Month for ever.

Firſt find what day of the Week the firſt of *January* is on; which is thus done: Firſt find the Dominical Letter for the laſt Leap-year, ſet down in the Almanack: the next letter is for the next year following, and ſo till you come to the year you look for: And note, every Leap-year hath two Dominical letters, *viz.* the next before it, till the 24 of *February*, and that over it for the remainder of the year: Having found it, reckon from (*A*) either backwards or forwards, (always calling (*A*) Sunday) you ſhall find what day is the firſt of *January.*

Example.

For the year 1655 (*F*) is the Dominical Letter; therefore ſay (*A*) Sunday, (*G*) Monday, (*F*) Tueſday, and that is the firſt of *January*;

and then make uſe of that thus: On the firſt Tueſday in the beginning of *February*, I would know the day of the Month? Among the Months look for 12, which is for *February*, reckoning from *March*, (which is always the firſt Month) and right under 12 you have 5, for the fifth day, being the firſt Tueſday in *February*, and 12, 19, 26 for the other Tueſdays in *February*: But now for the other Months after *March*, you muſt ſay Wedneſday, the reaſon is, becauſe *February* hath 29 days, and the Leap-year two Dominical Letters, *viz*. *F*. and *E*, then reckon from *E* to *A*, and it falls on Wedneſday, which uſe thus in the year 1656, and all other Leap-years: As, in the beginning of *Auguſt* on Thurſday, what day of the Month is it? *Auguſt* is the ſixth Month, look for 6 among the Months, and right under it you have 6, which is Wedneſday, therefore 7 is Thurſday, and the firſt Thurſday in *Auguſt*. But now for 1657. I find that Thurſday is the firſt of *January*; ſaying thus, *(A)* Sunday, *(B)* Saturday, *(C)* Friday, *(D)* Thurſday: And ſo it is all the year long, in all the Months; for having found the Moneth, all the days right under are Thurſdays, and then reckon onwards, or backwards for any other of the Week-days, and you have your deſire, for any year paſt, preſent, or to come.

PROB. 7.

To find the Epact, and by that the Moons age any day of the Month.

On the Leap-year you have it ſet down in the Almanack for the next year; add 11. and you have your deſire. And for the next year adde 11 to that, and ſo to the next leap-year: But if by ſo adding it exceed 30, then take away 30, and the remain is the Epact.

Having the Epact, add to it the day of the Month, and the number of the Month from *March* alſo, (including both the Moneths) and if they come not to 30, that is the Moons age; but if they exceed 30, and the Month hath 31 days, then Subſtract 30, and the remain is the age, but if the month have but 30 days, then ſubſtract but 29, and the remainder is the age of the Moon required.

Example.

In *July*, 1656. on the 20 day the Epact is 14. then 14.20 and 5 added, is 39. from which take 30, reſt 9 days old on the 20 of *July*, 1656. the Moons age ſought for.

PROB. 8.

To find the hour of the day.

Having found the day of the month by the Almanack, you muſt find the mark, or the ſpace between two marks in the Kalender, repreſenting that day; which do thus:

Look for the firſt letter, or name of the month in the Kalender, according to the time of the year, then reckon from thence to the day you are in, either by 5,10,15,20,25,30, 31, if the parts are ſo divided, as in ſmall Inſtruments they cannot well

be

e more ; but if you have ſingle days, very fifth and tenth is known from ie reſt by a longer ſtroke , and the aſt day by the longeſt ſtroke : Well , aving found the day , or the place etween two ſtrokes repreſenting it , y a thred from the centre over that ay, (or for want of a thred, ſtick a in in the centre , and cauſe the ſhaow to fall upon the day) and then bſerve on which, or between which f the 25 or 19 lines the thred cuts ie 12 of clock line , for on that line nuſt you look for the hour all that ay : Before I come to example, I hall hint a plain word of the reaſon f this , which I find ſome to marvel t ; The hour of the day in this, and n moſt Inſtrumental-Dials, is given y the Suns height ; now all men know the Sun is not ſo high in Winer as in Summer, therefore the Sumner hour lines will not ſerve the Winter ; and alſo all men know they engthen by degrees gradually, thereore the Winter and Summer 12 , and conſequently the reſt of the hour lines, run ſloping upwards and downwards, as the days lengthen or ſhorten. This being premiſed and conſidered, an eaſier Dial (all things conſidered) cannot be had. Now for an Example or two:

Having found out the parallel of Declination, (for ſo is it called) if there be 25 lines, (or of the Suns riſing, if there be but 19) you may eaſily know it by the name at the end of it, or by being a prick-line, or the next to, or the 2 next to a prick line, *&c.* hang or hold the Dial up, as was taught in the 1 Problem, and you ſhall have the exact hour of the day, among the Summer or Winter hours, according to the time of the year.

Example.

On the 2 of *Aug.* 1656. I look fo (*A*) in the lower line of the months because the days ſhorten; and laying a ſtring (or cauſing a ſhadow to fall from the centre upon the 2 of *Auguſt*, which (if it hath not a particu-

ar ſtroke for it) is a little beyond the
long ſtroke by the *(A)* and toward
he *(S)*, and I obſerve the thred to
cut upon the line of Declination, cal-
ed 15, and alſo it is a prick line: (in
one of 25 lines (but almoſt midway
etween the firſt, beyond a prick line)
nd may be called the line of the Suns
iſing, at 4. and 41 min.) then I hold
p my Dial, and find at 8 a clock the
hadow to croſs the 8 of clock line;
uſt in the prick line, and at the ſame
nſtant, the Suns altitude is 30. 15,
nd the quadrat is 29, and the line of
hadows is 1. and 7 tenths, (that is
he ſhadow of a yard (or any thing)
eld upright, is the length of the yard,
nd 7 tenths more of another length
r yard) and note, that at 4 a clock
he ſame day the ſhadow will fall in
he ſame place exactly, as was hinted
efore; for equal hours from 12.
he Sun hath the like altitude at all
imes of the year; and if it is mor-
ing, the height increaſes; if after-
oon, then it decreaſeth, ſo that two

obſervations will reſolve the queſtion. But note,

Firſt for the months of *June* and *Decemb.* where the days are cloſe together, the reaſon is, becauſe the days at that time lengthen or ſhorten but a little; ſo muſt their ſpaces be on the inſtrument; if you ſhould miſs 3 or 4. days there, it makes no ſenſible error, take near as you can, and it ſufficeth. Alſo note the hours of 11 and 12 are neer together, therefore you muſt be ſo much the more cautious in obſerving to hold the Dial wel, and to look juſt on, or between the parallel of declination or riſing, and at 12 of the clock you may look in the Kalender for the day of the month, for juſt on that day will the ſhadow be at 12 of the clock, and ſhort of it (increaſing) before, (but decreaſing) after 12.

Note alſo on the 10 of *March*, and 13 of *September*, you muſt obſerve in the upper line; but on the 11 of *June*, and 11 of *December* on the

lowe

loweſt line, as the rules rehearſed make manifeſt.

Laſtly, if you meet with a Dial that hath the Kalender of Months on the backſide, then it is but laying a thred over the day, and on the line of Declination, the thred cuts the correſpondent number of Declination, as before; alſo the riſing, and true place, and amplitude, as I hinted before; Then having the number, look for the line on the other ſide that ſhall have the ſame number, and proceed as before. Thus much ſhall ſuffice for the Dial particular for one latitude.

The uſe of the other line to make it General, as alſo of a Joynt-rule to find the hour and azimuth, I ſhall refer you to the Book of the Joynt-rule, a book of this volume, fit to be bound up with it, being a very uſeful peice for *Dialling*, *Geometry*, *Aſtronomy*, and *Navigation*, and many other Mathematical Concluſions, and a portable univerſal Sea-Inſtrument as any whatſoever extant.

CHAP. III.

The Deſcription of a Univerſal Dial, for all Latitudes, from 0 *to* 66. 30. *of North or South Latitude.*

1. Firſt the Dial it ſelf is an oblong, made of Box, Braſs, or Silver, or the like, and at the ſhorteſt ſide it hath two ſights, either of it ſelf, or fitted into it: parallel to one of the ſhorteſt ſides.

2. It hath a Bracheolum (with a Thred, Bead, and Plummet faſtned to it:) that is 3 pieces of Braſs ſo fitted together, that being pinn'd on the middle, will reach to any of the lines of Latitude, and it may be cut away after the work is on, to a very comely Form, or left Square, as ſhall beſt pleaſe the Fancy.

3. Thirdly for the lines, on the Dial, conſider firſt the centre on the 6 of Clock line, where the tangents of Latitude begin, and paſs on to *66*.30,

being ſtraight parallel lines, drawn croſs the oblong to every ſingle Degree of Latitude: and you have them numbred with 10.20.30 40.50.60. 65. at both ends of thoſe lines.

4. Then you have from the Centre aforeſaid, long ſtreight ſloping lines, drawn to every 5 or 10 Degr. of the ſigns, and on that end next the ſights, on the middle line you have ♈ and ♎ from thence toward the left hand, you have 10. 20. ♉ and ♍: and then onwards the ſame way ſtill, 10. 20. ♊ and ♌: then 10. 20. ♋. on the other ſide, to the right hand you have 10. 20. ♓ and ♏ and 10. 20. ♒ and ♐ and 10. 20. ♑. In all 12 ſigns.

5. Alſo adjoyned to them, you have a Kalender of months and days, that knowing the day of the month, you have the ſign anſwering thereto.

6. You have the ſame ſigns as was above pourtrayed on the right ſide, and 5 and 10 parts reciprocal to the former ſigns and parts on the top.

7. You have the hour lines, parallel to the length of the oblong, and numbred with 12. 1.2.3.4.5.6.7.8. 9.10. 11. 12. on the upper end of them: and with 12. 11.10.9.8.7.6. 5.4.3.2.1.12. at the lower end.

8. About the 2 ſides oppoſite to the right upper corner, you have Degrees of Altitude, and Declination to find the Latitude, the uſe of which followeth, with as much brevity, and plainneſs as may be.

PROB. 1.

To find the Latitude.

Having the Suns Declination, and his Meridian Altitude, to find the Latitude.

When the Sun is juſt on the Meridian, obſerve his Altitude, and ſet it down: then find his Declination for that day, and conſider whether it be North or South, for if it be North Declination, you muſt ſubſtract it from it; if South you muſt adde it to the Meridian Altitude found, and the Sum, or remainder, ſhall be the complement of the Latitude ſought for.

Example.

I am on the firſt of *Auguſt*, in a place where the noon Altitude is 50 the Suns Declination the ſame day is 15. 18. North, which taken out of 50. there remains 34.40, whoſe complement to 90 is 55. 18. the Latitude ſought.

The Degrees have the ſigns added to them, ſo that when you have the Suns place by the help of the Kalender above, look for the like Suns place in the Degrees, and juſt againſt it, you have his Declination: and when you have the Latitude by this, or any other means, you may find the hour of the day in this manner.

PROB. 2.

To find the Hour of the Day.

Having the day of the Month, by the help of the Almanack as before; Find the ſame day in the Kalendar of Months and days, and right againſt it, you have the Suns place in the *Zodiack*, or 12 ſigns: then bring the end of the *Bracheolum* to the ſame ſign, or part of the ſign in your reſpective Latitude, and bring the Bead on the ſtring, to the ſame ſign and Degree, among the ſigns on the right ſide, then is it rectified for obſervation; then hold it up till you ſee the Sun-beams peirce through both holes of the ſights, the thred playing eaſily by the ſide, the ſame time the Bead will fall upon the hour of the day, if it be the forenoon reckon among the fore-noon hours, but if it be after-noon, among the after-noon hours, for the ſame as was 9 in the morning, is 3 in the afternoon, and ſo of the reſt.

On the 10 of *April*, in the Latitude of 51. 30, at 8 a Clock, I would find the hour of the day by this Inſtrument. Firſt, I look for the tenth of *April*, in the Kalendar, and right againſt it I find ♉, that is, the Sun is their entring ♉, then I come down in that line, till I come to the Latitude of 51. 30: and there I ſet the hole, in the end of the *Bracheolum*, where the thred is faſtned ; then that being fixed there , I bring the Bead on the ſtring, to the ſame ſign ♉,on the right hand ; and then it is rectified for that day and Latitude : then hold it up as before, and you ſhall find the Bead to fall on the line called 4 and 8 , that is 8 in the morning,and 4 in the afternoon. As before ſaid.

PROB. 3.

To find the time of the Suns riſing, or Setting.

Rectifie the inſtrument as before , and make the ſtring lie parallel to the hour-lines,and the bead will ſhew you the time of the Suns riſing, reckoning in the Morning hours, and his ſetting, reckoning in the after-noon hours ; and by them you may have the length of the day and night ; for if you reckon backward to 10 at night, you have the length of the night; the other way gives you the length of the day, being doubled.

Example.

On the 10 of *April*, the Index of

Bracheolum rectified, and the Bead ſet right, and the ſtring drawn ſtraight and parallel to the hours, the Bead falls on 5 for the Suns riſing, & 7 for his ſetting: then from 7 to 12 at night is 5 hours, which doubled is 10 hours, the length of the night; and from 5 to 12 at noon is 7, which doubled is 14 hours, the length of the day.

CHAP. IV.

The Deſcription and Uſe of the NOCTURNAL.

There are two places in the Nocturnal, or more commonly it is one plate of braſs on the backſide of another Inſtrument; for the one hath ōnly 34 hours, and each hour is divided into quarters, or more parts, as the largeneſs of the plate will admit: This Nocturnal hath the hour divided into 12 parts, that is, into 5 minutes a piece, and when the Nocturnal is added to another inſtrument, theſe hours and parts are ſet on that, and this one part of it.

The other part of it is a Rundle, or round plate of Braſs, on which is deſcribed, firſt and next the Edge, 365 diviſions, repreſenting the days of the year, every month having the name, at the beginning of it, or the firſt letter of the name, *viz.* I. F. M. A. M. I. I. A. S.O.N.D. and a longer ſtroke, at the laſt day, than any of the reſt; and figures at the tenth and twentieth day, for the more ready finding of it: next within, you have the 360 Degrees of a Circle, to find the right aſcenſion of any ſtar, and numbred with 10. 20.30.40.50. to 360. beginning at the tenth of *March*, and proceeding onwards as aforeſaid.

3. Then you have a Scale of Declinations, numbered both ways, from the Equator, and Pole, *viz.* 10. and 80, 20. & 70, 30. & 60. 40.& 50. 50 & 40, by which you may find the Declination, or diſtance from the Pole of any ſtar.

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4. You have 5 Conſtellations of thoſe Stars next the North-pole, and the reſt of the Stars of other conſtellations, as come within that compaſs. The names of which conſtellations are, the great Bear, the little Bear, Cephus, Caſſiopeia and the Dragon, and part of Perſeus, and Auriga.

5. You have a ſtring lying croſs the Diameter, from 12 to 12, for a Meridian. The uſes follow in order.

But for their ſakes that may be willing to know more Stars, than are here ſet down, I have provided a larger plate, all the noted Stars from the Northpole to the *Æquinoctial*, whoſe uſe is the ſame with this, therefore I ſhall ſpeak no more as to the uſe of that then this: only there is more variety, and it is a great help to the knowing of the Stars, for which cauſe it was by me chiefly compoſed.

Firſt then for the uſe, the moſt hard and difficult thing is to know the Stars one from another: The beſt means to know which next to a Tutor,

tor, is to compare them you do know in the Rundle with them in the heavens, and then one with another, as thus:

In a night when the Stars may be ſeen, and it is beſt for to learn when there is not ſo many Stars ſeen, (as there is in ſome clear froſty nights) for then onely thoſe in the Nocturnal will be ſeen: Look toward the North part of the heavens, and you ſhall ſee 7 fair Stars ſtanding as you ſee the 7 in the great Bear, beginning at the tail of the Bear; and the two laſt being bright Stars; from which two if you conceive a line to be drawn, it will cut the Pole-ſtar; and when you find the Pole-ſtar, and them two, they will help you to find all the reſt with diligent obſervation.

Another way to find the North-ſtar, is to hang a plummet on the Centre, and make it play on the degree of the latitude of the place, and then lift it up toward the North part of the heavens, till you ſee a bright ſtar, ſo bright, as one of the 7 in the great Bear, for that is the Pole-ſtar. *Note* that it is not the very Pole, as you may ſee by the *Nocturnal*, but it is the neareſt the Pole; this being known, and the great Bear, which almoſt every Country-man knows, by the name of *Charls-wane*; with help of the ſtring lying acroſs, you may ſtraight-way look Eaſt or Weſt North or South, or between, for any of the Stars ſet down in the Nocturnal, for the ſtring you muſt conceive to lye North and South always: By theſe or the like means you may come to know all the Stars in the Nocturnal. And if you attain to know them, with the help of the other paper, you may know all in the half-Hemiſphere that is between the Pole and Equinoctial.

Secondly, to find when any ſtar comes to the Meridian. The Meridian is a line or arch of a Circle, conceived to be drawn through (or rather by the ſtar in the tail of the little Bear, which is) the Pole Star, right over your head; and to make you underſtand this the better, Hang a line with a weight at the end of it, out of a window that looks to the North, a good way from the houſe, or on a tree, or corner of a houſe, and then go to and fro till you ſee the line cut by the North-ſtar, how much and on which ſide the Nocturnal will ſhew you, and that line, then is the meridian-line; and then what ſtar ſoever is under the line and the North-ſtar, or Pole, (for when you uſe the ſtars of *Caſſiopeia*, the ſtar is the true Pole, as by the Meridian-line on the Nocturnal you may plainly ſee) that ſtar I ſay is exactly on the Meridian, be it above or below the Pole; for ſo it be in that direct line with the Pole, it matters not, ſo you have the hours divided round about; but you may be able in a little practice to gueſs, without the Plumb-line, yet it will marvellouſly rectifie your judgment, till you be more ready at it. Theſe two being known, all the reſt is very eaſie as may be.

3. The day of the Month being given, and a Star on the Meridian, to ſind the hour of the night.

Suppoſe on the 1 of *Auguſt*, I ſee by the means beforeſaid, the Star in the tip of the great Bears tail, to be in the Meridian, then bring that Star juſt under the ſtring, and look for the 1 of *Auguſt*, and right againſt it you have 4 a Clock, and 8 minutes in the morning: Or elſe ſet the day of the month to 12, and then keep it fixed all that night, then the thred laid over the Star that is in the meridian, ſhall at the ſame time in the hours ſhew the hour, counting backwards.

Another Example.

Suppoſe on the ſame night the ſtar in the noſe of the Bear, were in the Meridian, then bring that ſtar under the ſtring, and the 1 of *Auguſt* will ſhew 10. 37, that is 37 minutes paſt 10 at night: the like is for any other.

4. To find the right aſcenſion of a ſtar, bring the ſtar under the thred,

and the thred ſheweth his right aſcenſion in the degrees, ſo you will find the right aſcenſion of the ſtar in the great Bears tail to be 203.

5. To find the declination of a ſtar, bring the ſtar under the line, then prick a pin thorough the ſtring, and juſt in the middeſt of the ſtar, then keep the pin there; and bring the Scale of declination right under the line, and pin: and the pins point ſheweth you his declination, or diſtance from the Pole; by theſe two laſt, you may adde any ſtar, whoſe right aſcenſion, and declination you know; and ſo put in all, as may be ſeen in this compaſs, at any time or by the right aſcenſion only (being ſufficient for this purpoſe, to wit the hour of the night,) you may add the Buls eye, little Dog, 7 Stars, Orion, or any other chief principal fixed ſtar: and make uſe of it, to find the hour of the night withal.

6. The day of the month, and hour being given, to know what ſtar is

on or neer the meridian. Set the day of the month to the hour of the night, and the ſtars that are under the ſtring, are all on the meridian: and if there be none juſt, you ſhall ſee what half, or 3, or 4 part, between 2 is on the meridian, and this is an excellent way to help you to know the ſtars.

Alſo note, That to uſe this Paper peice paſted on a Board, and not to turn about, do thus;

Lay a thred on the Star you find to be in the Meridian, then with a pair of Compaſſes meaſure from the thred to the next 12, the ſame extent laid the ſame way, in the line of months and hours, ſhall reach from the day of the month to the hour required.

FINIS.

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The Uſe of the
LINE of NUMBERS
ON A
SLIDING (or GLASIERS)
RULE,

In *Arithmatique* & *Geometry*.

AS ALSO,

A moſt Excellent contrivance of the Line of Numbers, for the Meaſuring of Timber, either Round or Square, being the moſt eaſie, ſpeedy, and exact, as ever was uſed.

WHEREBY

At one ſetting to the length, all ordinary peices of Timber, from one Inch to 100 Foot, is with a glance of the eye reſolved, without Pen or Compaſſes.

Firſt drawn by Mr. White, *and ſince much inlarged, and made eaſie, and uſeful, by* John Brown.

London, Printed in the Year, 1656.

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The Uſe of the LINE of NUMBERS ON A SLIDING-RULE,

For the meaſuring of *Superficial* or *Solid-meaſures.*

CHAP. I.

A Sliding-rule is onely two Rules, or Rule-pieces fitted together, with a Braſſe-ſocket at each end, that they ſlip not out of the grove; and the Line of Numbers thereon, is cut acroſs the moving Joynt on each piece, the ſame diviſions on both ſides: only the placing of the lines differ, for on one ſide of the Rule you have 1 ſet at the beginning, and 10 at the end on each piece; but on the other ſide 1 is ſet in the middle, and the reſt of the figures anſwerably both ways; on purpoſe to make it large, and to take in all numbers; and the reading of this is the very ſame with the other; for if you pull out the Rule, and ſet 10 at the end, right againſt 1 at the beginning, then on both pieces, you have the former Line of Numbers completely; therefore I ſhall ſay nothing as to deſcription, or reading of it, but come ſtreight to the uſe.

On the edges of the Rule is uſually ſet Foot-meaſure, being the Foot or 12 Inches parted into 100 parts; and on the flat ſides next to the Foot-meaſure, Inches in 8 parts; and on the other flat edges on the other ſide, the Line of Board-meaſure, and ſometime Timber-meaſure, whoſe uſe is ſhewed in the firſt Chapter of the Book; but note if the Rule be a juſt Foot when it is ſhut, as Glaſiers commonly have it, then the Inches are ſet alike on both ſides, and the Foot-meaſure alike on both edges: and being pulled out as far as the braſſes will ſuffer, it wants about one Inch of two Foot; but if you would have it to be two Foot juſt when pulled out, as it is made for Carpenters uſe, then the Inches on one ſide, and Foot-meaſure on the ſame reciprocal edge, muſt be figured otherwiſe, as 13. 14. 15. 16. 17. *&c.* to 25. Inches, and the Foot-meaſure with 110. near the end 120, 130, 140, 150, *&c.* with 210 at the very end, ſhewing the meaſure from end to end, being drawn out to any diſtance; as is very eaſie to conceive of, and need no example to illuſtrate it withal.

Note alſo in uſing the Line of Numbers, that that ſide or part of it, on which you find the firſt part or term in the queſtion, ſhall always call the firſt ſide, and then the other muſt needs be the ſecond, that the Rules and Examples may be ſhortned and made eaſie.

1. *Multiplication by the Sliding-rule.*

Set the 1 on any ſide, (which being found, I call the firſt ſide) to the Multiplicator on the other (or ſecond) ſide; then ſeek the Multiplicand on the firſt ſide, where 1 was: and right againſt it on the ſecond, is the Product required.

Example.

If I would Multiply 25 by 28, ſet 1 on the firſt ſide, 25 on the ſecond, then juſt againſt 28 on the firſt ſide, on the ſecond is 700:for the right naming the laſt figure and the true number of figures, you have a Rule in the 2. Chapter and 2. Problem of the *Carpenters-Rule*, As in page 28.

2. *Diviſion by the Rule.*

Set the Diviſor found always on the firſt ſide, to 1 on the ſecond ſide, then right againſt the Dividend found out on the firſt ſide, on the ſecond is the Quotient required.

Example.

If I Divide 156 by 12, the Quotient is 13, note to find how many figures ſhall be in the Quotient, do thus, if the two firſt figures of the Diviſor, be greater than the two firſt figures of the Dividend, then the Quotient hath ſo many places or figures as there is more in the Dividend then in the Diviſor; but if it be leſs, that is to ſay, the Dividends two firſt figures greater than the Diviſors, then the Quotient ſhall have one place or figure more: then the Dividend exceeds the Diviſor.

Example.

2964 Divided by 39 makes a Quotient 76, of two figures, but if you Divide the ſame number by 18, you ſhall have the figures in the Quotient, *viz.* 164. and 12 remaining, or by the Rule two third parts of one more for the reaſon aboveſaid, the two firſt figures of the Dividend being greater

than

than the Diviſor, it muſt have one place more than the difference of the number of figures, in the Multiplicator and Multiplicand.

3. *The Rule of 3. direct.*

Set the firſt term of the queſtion ſought out on the firſt ſide, to the ſecond term of the queſtion on the ſecond (or other) ſide: then right againſt the third term, found out on the firſt ſide, on the ſecond ſide is the fourth proportional term required.

Example.

If 2 Yards of cloath coſt 8 *s.* what coſt 11 yards ½? the anſwer is 46 *s.* for if you ſet 2 on any one ſide, to 8 on the other, then look for 11 ½ on the firſt ſide where 2 was, and right againſt it on the ſecond you ſhall find 46, the number required. Note that all your Fractions on the Line of Numbers are Decimal Fractions, and to work them, you muſt reduce your proper Fractions to them, which for ordinary Fractions you may do it by Inches and Foot-meaſure; but this general Rule by the numbers will reduce any kind whatſoever, as thus: Suppoſe I would have the Decimal fraction of 9 Foot 7 Inches $\frac{3}{4}$, firſt note that 9 are Integers, for the reſt, ſay thus, as 48 the number of Quarters in (12 Inches or) one Foot, is to 1000; ſo is 31 the number of Quarters in 7 Inches 3 Quarters, to 645 the Decimal Fraction required, for 9645 is equal to 9 Foot 7 Inches $\frac{3}{4}$, and ſo for any other whatſoever.

4. *To work the Rule of 3. reverſe.*

Set the firſt term ſought out on the firſt ſide, to the ſecond being of the ſame denomination on the ſecond line or ſide, then ſeek the third term on the ſecond ſide, and on the firſt you ſhall have the anſwer required.

Example.

If 48 men perform a piece of work in 24 hours, how many men may there be to do the like in 4 hours, ſet 24 on the firſt ſide, to 4 on the ſecond, then right againſt 48 found out on the ſecond, on the firſt is 288 the number of men required.

5. *To work the double Rule of 3 direct.*

To perform this, you muſt have two working: As thus, for an

Example.

If the increaſe of 3 Buſhels of wheat in one year be 36 Buſhels, what ſhall the increaſe of 8 Buſhels be for 7 years?

Firſt, ſet 3 on the firſt ſide, to 36 on the ſecond, then againſt 8 on the firſt, on the ſecond you find *96*, then ſet 1 on the firſt ſide to *96*, then againſt 7 on the firſt ſide on the ſecond you have *612*, the increaſe in 7 years, the anſwer required.

CHAP. II.

To meaſure Board or Glaſs by the Sliding-rule, the length and breadth being given.

PROB. 1.

The breadth given to find how much makes a Foot.

If the breadth be given in Inches, then ſet 12 on the firſt ſide, to the Inches on the ſecond: then right againſt 12 on the ſecond, on the firſt is the number of Inches required.

Example.

At 6 Inches broad, ſet 12 to 6, then againſt 12 on the ſecond, on the firſt you have 24. But if it be given in Foot-meaſure, then in ſtead of 12, uſe 1. and do in like manner as before.

Example.

At 0. 50 broad, ſet 1 to 0. 50, then right againſt the other 1, is 2,00 the anſwer required.

But to find how much is in a foot long at any breadth, do thus:

Firſt for Foot-meaſure, juſt as the Rule ſtands even look for the breadth on one ſide, and the quantity in a foot is on the other ſide, but for Inches ſet 1 to 12. then right againſt the Inches broad is the feet and tenth in a Foot-long.

Example. At 6 Inches broad is 50

or half a foot in a foot long. Again at 30 Inches broad is 2 foot and a half in a foot long.

PROB. 2.

The length and breadth given to find the content.

Firſt the breadth given in Inches, and the length in Feet and Inches; ſet 12 on the firſt ſide, to the breadth on the ſecond; then right againſt the length on the firſt, on the ſecond is the content required.

Example.

At 16 Inches broad, and 20 Foot long: Set 12 to 16, then right againſt 20, you have 26 Foot 7 10th. look for your 7 10th. on the Foot-meaſure, and right againſt it on the Inches, you have 8 Inches ¼ and ½ Quarter, the anſwer deſired.

But if the breadth be given in Foot-meaſure, then ſet 1 to the breadth; then right againſt the length on the firſt ſide, on the ſecond you ſhall have the Content required.

Example.

Example.

At 1. 20 broad 20. 00 Foot long: you ſhall find 24 Foot. For if you ſet 1 to 1. 20, then right againſt 20 Foot, you have on the ſecond 24 as before.

PROB. 3.

The breadth given in Feet and Inches, and the length alſo in the ſame parts, to find the Content.

Set 1 on the firſt ſide to the Feet and Inches brought to a Decimal Fraction, or as near as you can gueſs, (for 6 Inches is half, 3 Inches is one quarter, 9 Inches is the quarters, 4 Inches is one third, 8 Inches is two thirds, and 1 Inch is ſomewhat leſs than one tenth on Rule,) on the other or ſecond ſide; then right againſt the length found on the firſt, on the ſecond is the Content required.

Example.

At 3 Foot 3 Inches broad, and 9 Foot 9 Inches long: you ſhall have 31 Foot 8 Inches ½ near, the very ſame is for Foot-meaſure, (only much eaſier) becauſe the diviſions on the Line of Numbers, and on the Line of Foot-meaſure on the edge, do agree together.

This being premiſed as to the uſing of it, you may apply all the former precepts and examples to this Rule as well as the other.

CHAP. III.

To meaſure Timber by the Sliding-rule.

PROB. 1.

To meaſure Timber by this Rule, is nothing elſe but to work the Double-Rule of Three.

As for Example.

At 8 Inches ſquare, and 20 Foot long, I would know the Content.

Set 12 if the ſide of the ſquare be given in Inches, (or 1 if in Foot-meaſure) on the firſt ſide, to 8 the Inches ſquare on the ſecond: then right againſt 12 on the ſecond ſide, on the firſt is 18, the fourth proportional part. Then for the ſecond work, ſet 18 the fourth proportional laſt found to 8 the Inches ſquare on the ſecond, then right againſt 20 the length is, 9. the Content required.

Or rather thus;

Set 12 againſt 8, then right againſt 20 on the ſame ſide 12 was, is 13.5 neer on then look for 13. 5 *ferè* on the firſt ſide, and right againſt it on the ſecond, is 9 foot, the Content required.

PROB. 2.

To meaſure a piece that is not ſquare.

Set 12 if you uſe the Inches, (or 1 if you uſe Foot-meaſure) on the firſt ſide, to the Inches thick on the ſecond; then right againſt the Inches broad on the firſt ſide, on the ſecond is a fourth proportional: then in the ſecond operation, ſet 12 on the firſt ſide, to the fourth proportional on the ſecond, then right againſt the length on the firſt ſide, on the ſecond is the Content required.

Example.

At 8 Inches thick, and 16 broad, and 20 Foot long, you ſhall find 18 Foot *ferè.*

PROB. 3.

The Square given, to find how much makes a Foot.

Set the Inches ſquare on the firſt ſide, to 12 on the ſecond; then right againſt 12 on the firſt, on the ſecond is a fourth proportional number: then in the ſecond work, as the Inches ſquare to the fourth proportional, ſo is 12 to the number of Inches required, to make a Foot of Timber.

Example.

At 6 Inches ſquare, ſet 6 to 12, then agaiuſt the other 12 is 24: then ſet 6 to 24, then right againſt 12, you ſhall have 48. the length in Inches required.

After the ſame manner are other queſtions wrought, but the Compaſſes are eaſier, and more ready; therefore I ſhall ſay no more to this, but only refer you to the former rules in the third, fourth, and fifth Chapters. Only note that in thoſe Sliding-rules made for Glaſiers uſe, the one half of the Line of Numbers is on one ſide of the Rule, and the other on the other: and whatſoever leg, or piece of the rule, is the firſt on the one ſide, the ſame leg or piece is the firſt when the Rule is turned on the other ſide, which muſt well be obſerved; but note that for meaſuring of Timber, thoſe that uſe it may have one ſide fitted for that, as I ſhall more plainly and fully ſhew in the next Chapter, being the eaſieſt, ſpeedieſt, and neat way, that ever yet was uſed by any man, reſolving any Contents, by having the length, and the diameter, circumference, or ſquare given.

A Table of the true Siſe of Glaſiers Quarries *both long and ſquare, calculated by* J. B.

Square Quarries 77. 19 gr.

Ranger	*Sides*	*breadth*	*length*	*content in Feet.*	*content in Inch.*
in. 100	*i.* 100	*I. p.*	*I. pts.*	*F. parts*	*Inc. p.*
4 20-	4 30	5 36-	6 70	0.1250	1.50
3 76	3 84	4 80	6 00	0.1000	1.20
3 43.	3 51	4 38-	5 47-	0.0833	1.00
3 07.	3 13-	3 92-	4 90	0.0667	0.80
2 80	2 86.	3 57	4 47.	0.0555	0.666
2 66.	2 72	3 39-	4 24	0.5000	0.60

Long Quarries 67. 22.

Ranger	*Sides*	*breadth*	*length*	*content*	*content*
In pts.	*I pts.*	*I.* 100	*I. pts.*	*F.* 100	*I. pts.*
4 09	4 41.	4.90	7.34	0.1250	1.50
3 65-	3.95-	4.38-	6.57	0.1000	1.20
3 34	3.61	4.00	6.00	0.0833	1.00
2 98.	3 23	3.58	5.37	0.0667	0.80
2 58	2 79-	3.10	4.90	0.0555	0.666
2 72-	2 94-	3.27	4.65	0.0500	0. 60

Note that a prick after the 100 parts of an Inch, notes a quarter, and a ſtroke - a half of 100 part of an Inch; to make this Table work thus by the Line of Numbers.

Divide the diſtance between the content of ſome known ſize, as ſquare 10*s.* or long 12*s.* and the content of the inquired Size, into two equal parts, for that diſtance laid the right way, (increaſing for a bigger, or decreaſing for a leſs) from the ſides of the known ſize, ſhall give the reciprocal ſides of the inquired ſize.

Example for ſquare 12*s.*

The half diſtance on the line of Numbers, between 1000 the content of ſquare 10*s.* and 0. 833 the content of ſquare 12 ſhall reach from 6 the length of ſquare 10 *s.* to 5 47- the length of ſquare 12*s.* and from 4. 80 the breadth of ſquare 10*s.* to 4 38- the breadth of ſquare 12*s*, and from 3 84- to 3. 51 and from 3 76 to 3 43; and ſo for all the reſt.

CHAP. IV.

The deſcription of the Line of Numbers on a Sliding-rule, to meaſure Solid meaſure onely, according to Mr. White'*s firſt contrivance, but much augmented by* J. B.

Firſt, when the figures (on the Timber-ſide) ſtand right toward you, fit to read: then that half or piece next to your right-hand, I call the right-ſide, the other is of neceſſity the left.

Secondly, the figures on the right ſide are, firſt at the lower end, (where the Braſs is pin'd faſt) either 3, or 4, or 5, it matters not much which, yet to have 3 there is beſt: then upwards 4. 5. 6. 7. 8. 9. 10. 11, for ſo many Inches, then 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12, under the braſs at the top, for ſo many Feet: the diviſions between to one Foot, are quarters of Inches the next above 1 Foot, are only whole Inches, as you may plainly ſee.

Thirdly, at 1 Foot you have the word Square, at 1 Foot 1 Inch $\frac{1}{2}$ is a Mark, and right againſt it is ſet T D, noting the true Diameter of a round ſolid body; at an Inch further is 12 ſet, which I call ſmall 12, being in ſmall figures. Again at 1 Foot 3 Inches better, is another Mark, and right againſt it the word Diameter, for the Diameter of a piece of Timber according to the uſual Engliſh allowance. Then again at 3 Foot 6 Inches $\frac{1}{2}$ neer, is T R, for the true circumference of a round Cillender. Laſtly, at 4 Foot is the word Round, noting the circumference according to the uſual allowance, whoſe uſe followeth.

Note alſo if you put on the Gage-points for Ale or Wine, with the mean Diameter, and length, you may Gage any Wine or Beer-veſſel, the Wine at 17 Inches $\frac{1}{4}$: the Ale or Beer at 18.95.

Fourthly, the figures on the left ſide, are not much unlike the right, for 1 at the beginning is one Inch, and ſo it proceeds by quarters of Inches to one Foot; then by figures at the Feet, and the diviſions all whole Inches to 10 Foot, then every whole Foot, and half and quarter, or 10th. to 100, or 140, or 150 Foot; and this I call the left-ſide, the other the right ſide; ſo that from one Inch at the lower end, to one Foot, every Inch hath a figure; from one Foot to 10 Foot, every Foot hath a figure, and from 10 Foot to a 100, every 10th. Foot only is figured. I have been very plain in explaining this, becauſe I would avoid vain repetitions in the following uſes, wherein you ſhall have firſt the moſt ordinary and eaſie queſtions, and then the more hard and critical, and leſs uſeful.

The Uſes follow.

PROB. 1.

A piece of Timber being not ſquare, to make it ſquare.

Set the breadth on the left ſide, to the breadth on the right, then right againſt the Inch and quarters thick found on the left ſide, on the right is the Inches ſquare required.

Example.

At 18 broad, and 6 thick, you ſhall find 10 Inch $\frac{3}{8}$ the ſide of the ſquare required.

For if you ſet 6 inches againſt 6 Inches, on the right and left-ſide: then right againſt 18 Inches, or 1 Foot 6 Inches on the left, on the right you have 10 Inches 1 quarter and half a quarter: for the ſide of the ſquare equal to 18 one way, and 6 the other way.

PROB. 2.

The ſide of the ſquare given, to find how much makes a foot.

For all pieces between 3 or 4 Inches, and 42 Inches ſquare, which are the moſt uſual: this is the beſt way, ſet the Inches or Feet, and Inches ſquare, found out on the right-ſide, to one Foot on the left, then right againſt one Foot on the right, on the left is the Inches, or Feet, and Inches required , to make a Foot of Timber.

Example.

At 8 Inches ſquare ſet 8 on the right, to 1 Foot on the left, then right againſt 1 Foot on the right , on the left is 2 Foot 3 Inches the length required.

To find how much is in a foot long.

Juſt as the Rule ſtands even , look for the Inches, the peice is ſquare on the right and on the left is the Inches or feet and Inches required.

Example. At 17 Inches ſquare, there is 2 foot of Timber in one foot long, which if you multiply by the length , you ſhall have the true content. A very good way for large peices and very exact.

PROB. 3.

The ſide of the ſquare and length given to find the Content.

For all pieces between one Inch or $\frac{1}{12}$ part of a Foot, and 100 Foot, this is the eaſieſt way. Set the word ſquare or 1 Foot to the length on the left, then right againſt the Inches, or Feet and Inches ſquare on the right, on the left you have the Content.

Example.

At 9 Inch ſquare, and 20 Foot long: Set the (long ſtroke by the) word ſquare, to 20 Foot on the left, then right againſt 9 Inches on the right ſide, on the left-ſide you have 11 Foot and a quarter the Content required.

But if it be a very great piece, as above 100 Foot, then call one Foot on the left ſide 10 Foot, and 2 Foot 20. *&c.* then 10 ſhall be 100. and 100. a 1000, that will ſupply to 1500 Foot in a piece, but if you would go to a bigger piece, then call 2 Foot on the left 200, *&c.* then you ſhall have it to 150000 Foot in a piece, ſuch as I never ſaw.

But for all ſmall pieces under 3 Inches ſquare, and above 1 quarter of an Inch, do thus: Set 12 on the top

(or the ſmall 12 when it is moſt convenient to uſe) to the length on the left-ſide, then right againſt the inches (or 12*s*. of one inch) ſquares found on the right-ſide, on the left is the true Content required.

Example.

At 2 Inches (3 twelves or) 1 quarter ſquare, and 10 Foot long, you ſhall find 4 Inches and a quarter, *ferè*. But note when you uſe the ſmall 12, the anſwer is given in decimals of a Foot, therefore the top 12 is beſt.

PROB. 4.

The ſquare of a ſmall piece of Timber given, to find how much makes a Foot.

For all pieces from 12 Inches to 1 Inch ſquare, do thus: Set the Inches and (12*s*. or) quarters ſquare, counting one Foot on the right ſide for one Inch, and 2 Foot for 2 Inches, *&c.* found out on the right-ſide to 100 on the left; then right againſt the upper or ſmall 12 on the right, on the left is the length required, to make a Foot of Timber.

Example.

At 2 Inches ¼ ſquare, you muſt have 28 Foot 4 Inches to make a Foot.

PROB. 5.

Under 1 Inch ſquare to find the length of a Foot.

Set 1 Foot 9 Inches, 6 Inches, or 3 Inches, found on the right-ſide, for one Inch ¾, ½, or ¼ of an Inch, againſt 10 on the left-ſide, counted for 100 : then right againſt the ſmall 12, you have the Feet in length required.

Example.

At 1 Inch ſquare, you find 144 Feet, at ¾ ſquare 256 Feet, at ½ an Inch ſquare 576 Feet, at ¼ or an Inch ſquare, you find 2034 Feet, in length to make one Foot of Timber.

Or if you ſet the former numbers 12, 9, 6, 1, againſt 1 Inch on the left, then right againſt the upper 12, is a number, which multiplyed by 12, is the number of Feet required.

PROB. 6.

A great piece above 3 Foot ½ ſquare, to find the length of a Foot.

Set the Feet and Inches on the right, to 100 on the left: then right againſt ſmall 12, is the Inches and 12*s*, or 12*s* of a 12*th*. that goes to make a Foot.

Example.

At 4 Foot ſquare, you have 9. 12*ths*. or ¾ of an Inch to make a Foot of Timber: at 5 Foot ſquare 5. 12*ths*, and 10. 12*ths*. of a 12*th*. to make a Foot.

Thus you ſee the Rule as now contrived, reſolves from 1 quarter ſquare, to 12 Foot ſquare, the Content or Quantity of a Foot of Timber in length at any ſquareneſs, without Pen or Compaſſes.

CHAP. V.

For round Timber.

PROB. I.

The number of Inches that a piece of timber is about, being given, to find how much makes a Foot.

Firſt, for all ordinary pieces, ſet one foot on the left, to the inches or feet, and inches above on the right, then right againſt TR for true meaſure, or round for the uſual meaſure, is the feet, or feet and inches required, to make a foot of timber, at that circumference about.

Example.

At 4 inches about, 113 foot 2 inches is for true meaſure, but for the uſual meaſure, 142 foot goes to make a foot of Timber.

At 12 foot 3 inches about, 1 Inch is a true foot, but for the uſual allowance,

ance, as the fourth part of a line girt about gives: it muſt be 1 inch $\frac{1}{4}$ long, to make a foot of Timber at that circumference.

But for very large pieces, count 1 foot on the right for 12 foot, 2. 24, *&c.* and ſet 1 foot on the left as before, then in the anſwer, 1 foot on the left is 1. 12*th.* of an inch, and 1 inch 1. 144*th.* of an inch.

Example.

At 144 foot about, 1. 144*th* part of an inch, is a foot of Timber.

PROB. 2.

For very ſmall Wood to find a Foot in length.

But for very ſmall pieces of under 4 inches about, ſet 1 foot, 2 foot, *&c.* on the right, (counted for 1 inch, 2 inches, 3 inches, or 4 inches) to one foot on the left, then right againſt T R or round, you have a number, which Multiplyed by 12 is the number of feet required.

Example.

At one inch round true meaſure, is

151 foot *ferè*, but for the uſual allowance 196, which numbers Multiplyed by 12, is the number of feet required, *viz.* 1809, and 2352. but note you muſt read the 196, and 151 right, as thus: 1 foot on the left is 12, 2 is 24, *&c.* ſo that 12 foot is 144, and our number by the ſame account is 151 near.

To find how much is in a foot in length, Set round or T R to 1 foot on the left, then right againſt the inches, or feet and inches about 1 found on the right, on the left is the anſwer required.

PROB. 3.

The inches, or feet and inches about, and length given to find the content.

Set the word round, or T R for the uſual, or true meaſure, to the length on the left: then right againſt the inches about on the right, on the left is the content required.

Example.

At 2 foot 3 inches about, and 20

foot

foot long, it is 6 foot 2 inches of the uſual allowance, or 8 foot of true meaſure.

But if it be a great tree, then ſet T R, or round to 1 called 10, or to 10 called 100, then is the content augmented to 1000 foot, as you did in the Rules for ſquare timber.

But if you would have it meaſure bigger ſtill, then ſet the 4 inches or a TR ſet cloſe by the braſs on the right-ſide, to the length on the left, either as it is, or augmented, counting at laſt according: (then note one foot on the right is 12 foot, and 12 at the top is 144 foot:) then right againſt the feet about on the right, on the left is the content required.

Example.

A Brewers Tun 3 foot long or deep, and 72 foot about, ſet the T R by the braſs to 36 inches (which is thus counted) on the left-ſide: (1 inch is 10 inches, 2 is 20, 3 is 30, 3 ½ is 35, ſomewhat more is 36. ſo then 1 foot is 120 inches, or 10 foot,) then right againſt 6 times 12 foot on the right, (which is at 6 foot) on the left you have 12 30 foot, as near as the Rule will give it, which counting 6 foot to a barrel, is 205 barrels the content required.

PROB. 4.

To find the content of a very ſmall piece.

Set the word round, or T R to the length on the left, as in the 3. Propoſitiou of this Chapter: then right againſt the inches about on the right, (calling one foot one inch, and 6 inches $\frac{1}{2}$ an inch,) on the left is the 12*s* of one inch,) or 12*s*. of a 12*th*. required.

Example.

At half an inch about, and 10 foot long, it is 2 12*s* and a half of one 12*th*. of an inch, or two ſquare inches and $\frac{1}{2}$ true meaſure. Again, 2 inches $\frac{3}{4}$ about, and 10 foot long, is half an inch of true meaſure, 12 inches to a foot ſolid, or $\frac{1}{2}$ a foot ſuperficial of one inch thick.

CHAP. VI.

To meaſure Timber, having the Diameter and the length given.

PROB. 1.

The diameter given in inches, to find the length of a foot.

Set one foot on the left, to the inches diameter on the right: then right againſt T D for true diameter, or the word diameter for the uſual allowance, (of a ſtring girt about and doubled 4 times for the ſide of the ſquare) you have the feet and inches required.

Example.

At 10 inches diameter, 1 foot 10 inches makes a foot.

But for very great pieces, ſet one foot as before, but look for T D beyond the upper 12, and right againſt it on the left you have the 12 of one inch, or the 12s. of a 12, that makes a foot.

But for very ſmall ſticks, ſet 1. 2. or 3 foot on the right, (for 1. 2. or 3 inches) to 1 foot on the left, then right againſt T D or Diameter you have a number, which multiplied by 12, is the number of feet required to make a foot of timber.

Example.

At one inch diameter, you ſhall have 15 foot 3 inches and better, which multiplied by 12 is 183 foot 3 inches. Note that 1 on the left is reckoned 10 foot, and 2, 20 foot, as before in the ſame rule, for the circumference, and then note 1 inch is 10 inches.

At any Diameter to ſind how much is in one foot long, do thus; Set Diam. or T D to 1 foot, then juſt againſt the inches or feet and inches Diameter found on the right, on the left is the anſwer.

Example.

At 2 Foot Diameter is 3 foot two inches in one foot in length which multiplyed by the length gives the true content of any round peice and very exactly.

PROB. 2.

The diameter and length given to find the true content.

For all ordinary pieces, ſet the word Diameter for the uſual meaſure, or T D for true meaſure, always to the length on the left: then right againſt the inches, or feet and inches Diameter on the right, on the left is the content required.

Example.

At 5 inches Diameter, and 30 foot long, you ſhall find 4 foot ½ an inch true meaſure, for the content required

But for very ſmall pieces, ſet T D or round to the length, as before; then counting 1 foot on the right for 1 inch, and 6 inches for ½ an inch; on the left you ſhall have the anſwer or content required. But note as the right-ſide is diminiſhed, ſo is the left, for one foot on the left is a 12*th* of 1 Inch of timber, whereof 12 makes a foot, or 1 long inch, a foot long, and 1 inch ſquare, and every inch on the left is 1 ſquare inch; thus at 2 foot long, and $\frac{1}{2}$ an inch diameter, it is 4 □ inches $\frac{3}{4}$ in content.

But for a great piece under a 1000 foot, ſet T D or diameter to 1. 2. or 3 foot, called 10. 20. or 30 foot: then right againſt the feet and inches diameter, you have a content augmented accordingly, as at 30 foot long, and 7 foot diameter, you have 1140 foot for the true content uſing T D.

But for very great pieces, as Brewers Tuns and the like, as in the 3 Propoſition of the 5 Chapter, you cannot work this without Compaſſes, and thus it is done, take the diſtance from the top 12 to T D, then ſet one point in one foot on the right, then ſlide the rule till the other point ſhall reach to the inches deep or long, reckoned as before in round meaſure, *viz.* 1 inch for 10 inches, 2 for 20, *&c.* on the left: then counting 2 foot on the right for 24 foot, *&c.* right againſt it on the left, you ſhall have the content in feet. But this is much eaſier wrought thus.

Set 3 foot on the right ſide the gage point for a Barrel, to 36 the depth in inches of a Tun, on the left, then right againſt 11 for 6 inches, the half of 23 foot is 53 in Barrels $\frac{1}{4}$ the fourth part of 213, the content according to 282 inches in a Gallon. Note, I count 3 foot on the left ſide for 30 inches, *&c.*

Example.

A Brewers Tun near 23 foot diameter, and 3 foot deep, will hold 1230 foot, *viz.* 205 Barrels, ſought. Thus much for the uſe of the Line of Numbers for Timber-meaſure.

Note that in the way of meaſuring Brewers Tuns, every 6 foot is a Beer-barrel, one foot 6 gallons, 2 inches 1 gallon, 144 ſquare inches, or 1 inch a pottle, 72 ſquare inches a quart 36 a pint, *&c.*

Note that in large Taper timber, whether ſquare or round, when it is meaſured by the uſual way, that is, by the middle ſquare or girt, or the 2 ſquares or girts put together, and the half counted for the equal ſquare, or girt: I ſay a ſquare of half the difference of the ſquares or girts, and one third part of the length is to be added to the former meaſure, as is proved in the circles of proportion *pag.* 50.

As thus for Example.

Suppoſe a Taper-piece be at one end 16 inches ſquare, at the other 30 inches ſquare, and 30 foot long: the ſquare in the middle is like to be 23 inches, the content then is 110 foot: now half the difference of the two ends ſquare, is 7 inches, and one third part of the length is 10 foot: a piece 7 inches ſquare, and 10 foot long, is 3 foot 5 inches: which added is 113 foot 5 inches: the true content of that taper piece aboveſaid.

The general way of Gaging by this Rule is thus:

Set the W. or the A. for Wine or

Ale-meaſure, alwayes to the length of the veſſel found out on the left. Then right againſt the mean Diameter found out on the right ſide, on the left is the anſwer required.

Example.

At 30 Inches Diameter and 36 long, you ſhall find about 90 gallons ½ Ale-meaſure.

The Gage-point for a Beer Barrel is neer 3 foot, and the Ale-Barrel neer 34 inches, which uſe thus:

Set 3 to the depth of the Tun, then right againſt the Meridian is the content in Barrels.

Example.

Set 3 to 36 Inches, and then right againſt 5 foot Diam. is 10 Barrels of Beer-meaſure, a very good and ſpeedy way.

FINIS.

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